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HANFORD ENVIRONMENTAL DOSIMETRY UPGRADE PROJECT

GENII - THE HANFORD ENVIRONMENTAL RADIATION DOSIMETRY SOFTWARE SYSTEM

VOLUME 2: USERS' MANUAL

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ABSTRACT

The Hanford Environmental Dosimetry Upgrade Project was undertaken to incorporate the internal dosimetry models recommended by the International Commission on Radiological Protection (ICRP) in updated versions of the environmental pathway analysis models used at Hanford. The resulting second generation of Hanford environmental dosimetry computer codes is compiled in the Hanford Environmental Dosimetry System (Generation II, or GENII). The purpose of this coupled system of computer codes is to analyze environmental contamination resulting from acute or chronic releases to, or initial contamination of, air, water, or soil. This is accomplished by calculating radiation doses to individuals or populations.

GENII is described in three volumes of documentation. This second volume is a Users' Manual, providing code structure, users' instructions, required system configurations, and QA-related topics. The first volume describes the theoretical considerations of the system. The third volume is a Code Maintenance Manual for the user who requires knowledge of code detail. It includes code logic diagrams, global dictionary, worksheets, example hand calculations, and listings of the code and its associated data libraries.

ACKNOWLEDGMENTS

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1.0 INTRODUCTION

At the direction of the U.S. Department of Energy (DOE), the Hanford Environmental Dosimetry Upgrade Project was undertaken at Pacific Northwest Laboratory (PNL)[a] to incorporate the internal dosimetry models recommended by the International Commission on Radiological Protection (ICRP) in updated versions of the environmental pathway analysis models used at Hanford. The resulting second generation of Hanford environmental dosimetry computer codes is compiled in the Hanford Environmental Dosimetry System (Generation II or GENII). The GENII system was developed by means of tasks designed to provide a state-of-the-art, technically peer-reviewed, documented set of programs for calculating radiation doses from radionuclides released to the environment. The initial task resulted in a system design requirements report, based on input from the community of potential Hanford users, providing general descriptions of the calculations that the final programs must perform. The recommendations of this report formed the basis for the remainder of the tasks, defining the elements that determined the equation formulation and parameter selection tasks. The complete report, Hanford Environmental Dosimetry Upgrade Project (HEDUP) Task 02-System Design Requirements, is included in Volume 1 as the appendix.

The general requirements of the system to be designed included the capabilities for calculating radiation doses for acute releases, with options for annual dose, committed dose, and accumulated dose; for calculating the same types of doses from chronic releases; for evaluating exposure pathways including direct exposure via water (swimming, boating, and fishing), soil (surface and buried sources), air (semi-infinite cloud and finite cloud geometries), inhalation pathways, and ingestion pathways. The release scenarios to be included were acute releases to air from ground level or elevated sources, or to water; chronic releases to air from ground level or elevated sources, or to water; and initial contamination of soil or surfaces. Source term variations to be accounted for included decay of radionuclides to the start of the exposure scenario, input of total radioactivity or specified

(a) Pacific Northwest Laboratory is operated by Battelle Memorial Institute for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830.

fractions, and input of measured concentrations in specified environmental media. Interfaces were to be provided for external calculations of atmospheric dispersion, geohydrology, biotic transport, and surface water transport. Target populations were identified by distance and direction for individuals, populations, and for intruders into contained sources. To accommodate the multitude of initial requirements on the design of the codes, the codes of the Hanford Environmental Dosimetry System were written to determine radiation doses to individuals or populations from a wide variety of potential exposure scenarios. The core system may be used to calculate annual doses, dose commitments, or accumulated doses from acute or chronic releases of radioactive materials to air or water.

The Hanford Environmental Dosimetry System (GENII) is composed of seven linked computer codes and their associated data libraries. These codes and their linkages are illustrated in Figure 1.1. The computer programs are of three types: user interfaces (i.e., interactive, menu-driven programs to

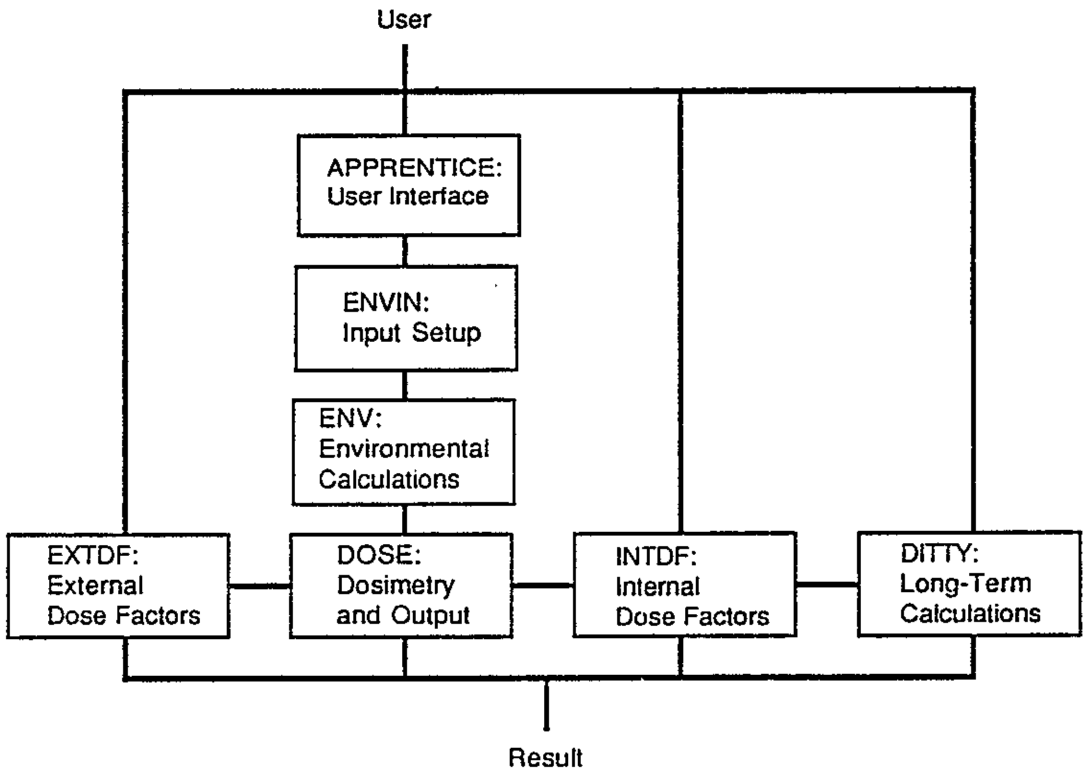

FIGURE 1.1. Component Programs of the GENII Software Package

assist the user with scenario generation and data input), internal and external dose factor generators, and the environmental dosimetry programs. For maximum flexibility, the portion of the code used for analysis of short-term scenarios (as opposed to 10,000-year migration analyses) has been divided into three interrelated but separate programs that handle input organization and checking, environmental exposure, and dose calculations, respectively.

GENII is described in three volumes of documentation. Volume 1 describes the theoretical considerations of the system, including conceptual diagrams, mathematical representation of the solutions, and descriptions of solution techniques, where appropriate. This, the second volume, is a Users' Manual, providing code structure, users' instructions, required system configurations, and topics related to quality assurance (QA). The third volume is a Code Maintenance Manual for the user who requires knowledge of code detail, including code logic diagrams, global dictionary, worksheets, example hand calculations, and listings of the code and its associated data libraries.

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2.0 CODE STRUCTURE

The GENII Software Package comprises several computer programs and data libraries. The computer programs fall into three categories: 1) user interface (e.g., interactive menu-driven program to assist the user with scenario generation), 2) internal and external dose factor generators, and 3) the environmental dosimetry programs. APPRENTICE is the user interface for the short-term environmental dosimetry programs; EXTDF and INTDF generate internal and external dose rate factors, respectively; DITTY handles long-term environmental dosimetry. For maximum flexibility, the short-term environmental dosimetry portion has been divided into three interrelated but separate programs (ENVIN, ENV, and DOSE) that handle input organization and checking, environmental exposure, and dose calculations, respectively.

Two user interaction levels are defined for the GENII software package. With the first, Level 0, the user interacts with the user interface. With the second, Level 1, the user interacts directly with the text input files. Level 0 is helpful to the both the novice and the experienced user of the software package. Level 1 is intended for the experienced user of the software. DITTY, EXTDF, and INTDF are available only to the Level 1 user at this time.

Figure 2.1 depicts the software organization and the user interaction with the programs.

Figure 2.2 illustrates the data transfer mechanisms between the various program elements. Each of these input, output, and intermediate files is described in Section 2.2.

Figure 2.3 illustrates the data bases and their relationships to the various program components. These are further described in Section 2.3.

2.1 USER INTERACTION LEVELS

Two user interaction levels are defined for the GENII software package. The first, designated Level 0, is that at which most users will interact with the system. In Level 0, the user accesses the interactive program

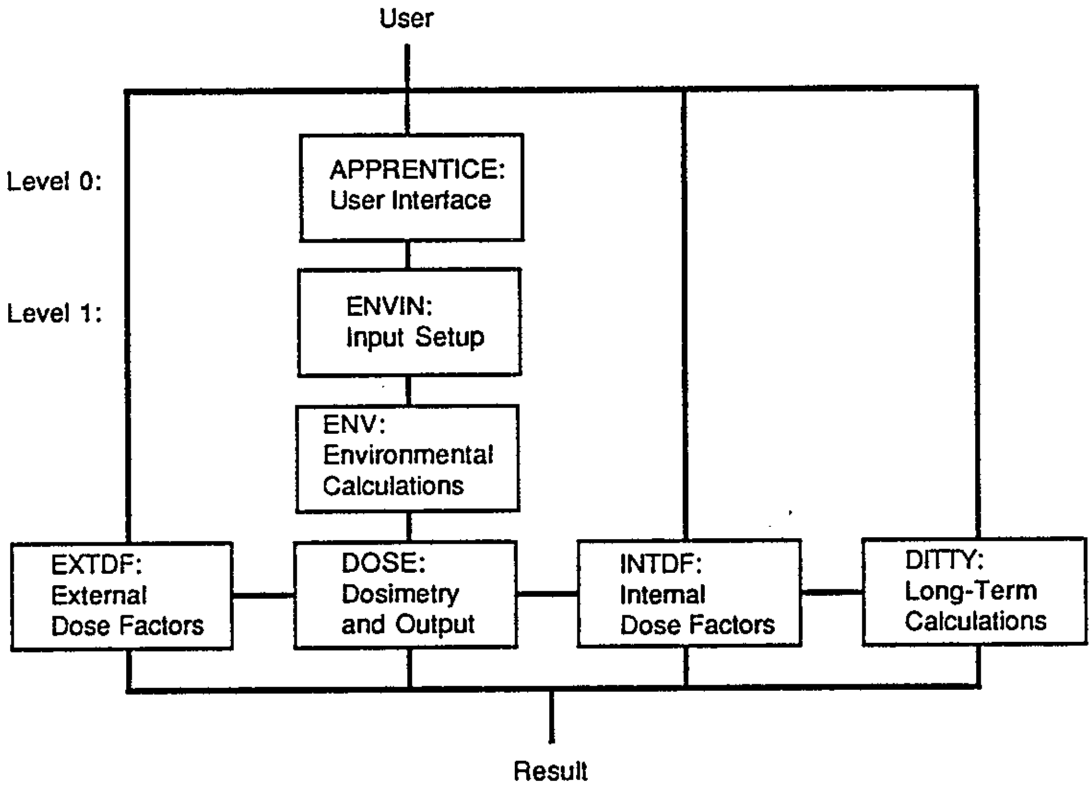


FIGURE 2.1. Organization and User Interaction Levels for the GENII Software Package

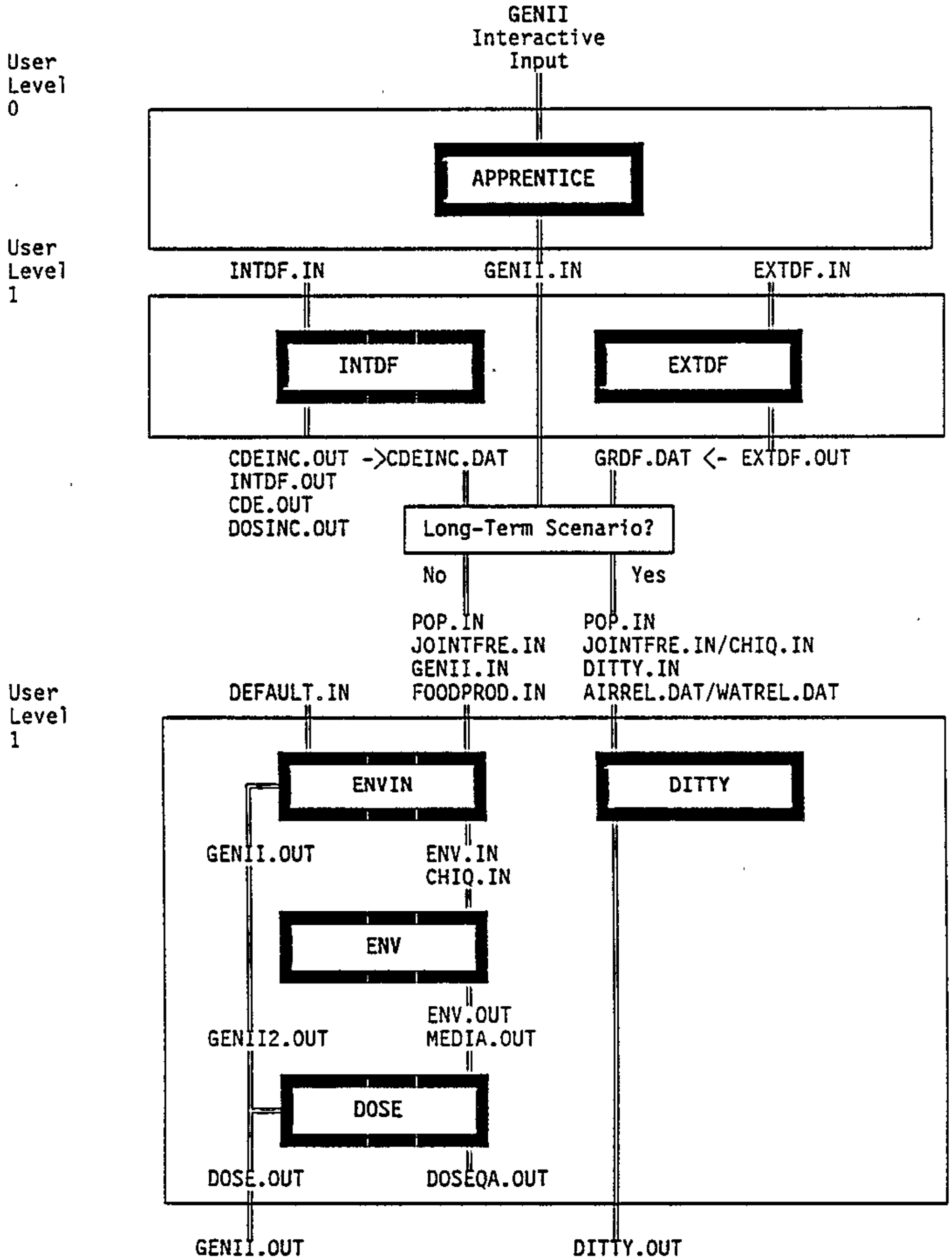


FIGURE 2.2. GENII File Relationships

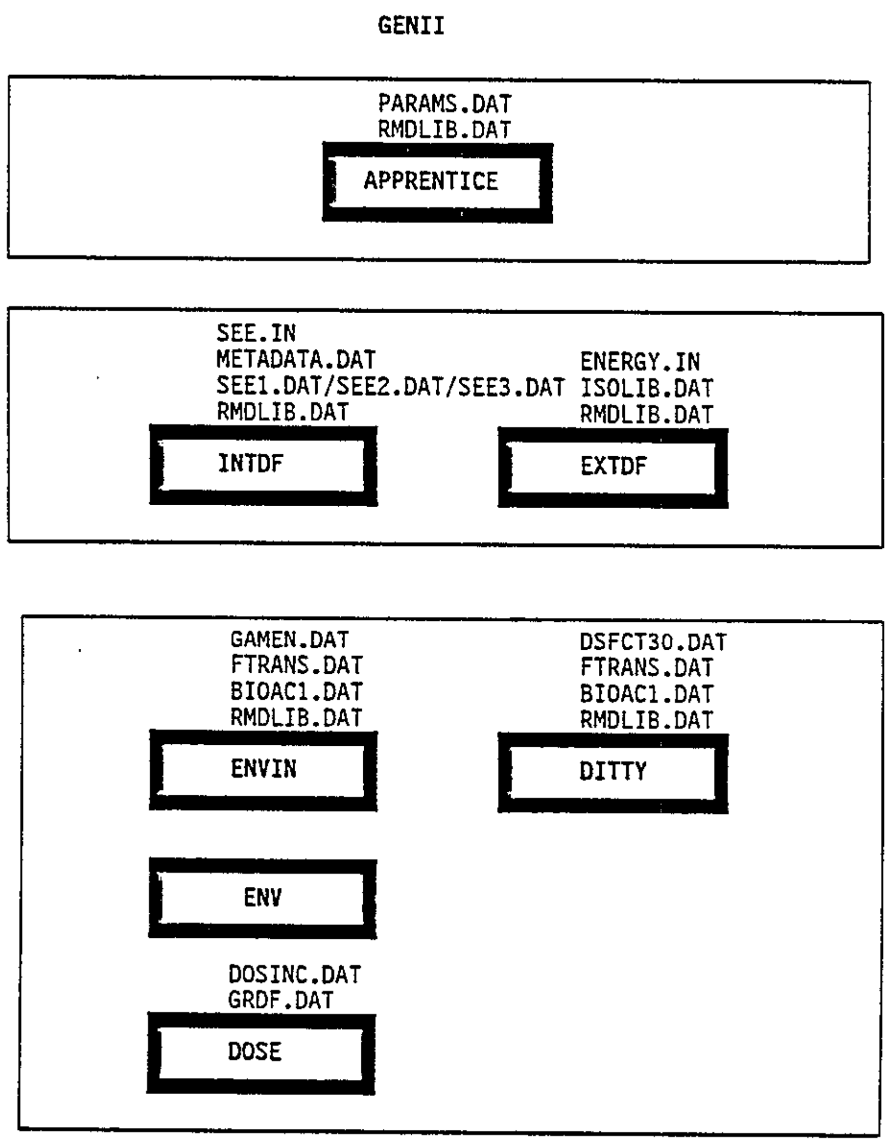


FIGURE 2.3. GENII Data File Requirements

APPRENTICE, which handles all file handling and data input necessary for most applications. In Level 1, the user himself must create input files and assure that all intermediate library and data transfer files are appropriately handled.

2.1.1 Level 0 User Interaction - Environmental Dosimetry

APPRENTICE is a menu-driven user interface intended to simplify input preparation for both novice and experienced users of this software package. APPRENTICE solicits needed information from the user and prepares a text input file for the environmental dosimetry programs. In addition, a batch-processing file is prepared to manage file handing.

Novice users will appreciate the pop-up help screens that are available in all sections of the program, the extensive logic that requests only pertinent input, default values available for all parameters, reasonable parameter value ranges, error checking for scenario incompatibilities, and checking for validity of file names. Experienced users will find that APPRENTICE has been constructed so that help does not "get in the way" of efficient scenario construction. Pull-down menus allow the user substantial flexibility to modify a scenario under construction. The user can create multiple input files to execute under control of a single batch-processing file which is generated by APPRENTICE in a relatively transparent manner. File management is available within APPRENTICE; the user may view, copy, and rename files as well as make subdirectories and change default paths.

The following is the general procedure for Level 0 users.

1. Create a work subdirectory on the same drive as that on which GENII is located:

    MD \mydir

    where **mydir** is the name of the work subdirectory you wish to create.

2. Set the work subdirectory to default:

    CD \mydir

3. Execute APPRENTICE by typing:

    \GENII\APPRENTICE

2.1.2 Level 1 User Interaction - Environmental Dosimetry

Level 1 interaction is useful for modifying previously existing GENII input files, (e.g., if a source term has changed and doses must be recalculated). APPRENTICE creates two files that the user may modify: nnnnnnnn.IN and nnnnnnnn.BAT, where nnnnnnnn is the file name specified in APPRENTICE. Nnnnnnnn.IN is the annotated input file to ENVIN/ENV/DOSE. Nnnnnnnn.BAT contains DOS commands that control program execution. Level 1 users modify these text files with a standard text editor and submit the batch-processing file as in Level 0. Sample files are included in Appendix A.

2.1.3 Level 1 User Interaction - External Dose Factors

EXTDF is a modified version of the ISOSHLD program. Input preparation for EXTDF is essentially the same as input preparation for ISOSHLD with the following exceptions:

- EXTDF is primarily a library generator. Consequently, the specification of radionuclides has been deleted from input. EXTDF automatically generates dose factors for all radionuclides listed in the master radionuclide library (file: RMDLIB.DAT). Energies of implicit daughters (listed to the right of the radionuclide in RMDLIB.DAT) are included with the parent.
- EXTDF outputs effective dose equivalent. (For surface-dose-to-effective-dose-equivalent conversion factors see Section 4.4.1 of Volume 1.)
- EXTDF expects its input to be located in the file buffer named **\GENII\EXTDF.IN** and will place output in the file buffer named **\GENII\EXTDF.OUT**. To execute, type the following commands:

```
COPY nnnnnnnn.IN \GENII\EXTDF.IN
\GENII\EXTDF
COPY \GENII\EXTDF.OUT nnnnnnnn.OUT
```

where **nnnnnnnn** is the unique file name of your EXTDF input. A sample input file is located in Appendix A.

2.1.4 Level 1 User Interaction - Internal Dose Factors

INTDF calculates integrated retentions and committed dose equivalents for radionuclides included in the master radionuclide library (file: RMDLIB.DAT).

- INTDF expects its input to be located in the file buffer named **\GENII\INTDF.IN** and will place output in the file buffer named **\GENII\INTDF.OUT**. To execute, type the following commands:

```
COPY nnnnnnnn.IN \GENII\INTDF.IN
\GENII\INTDF
COPY \GENII\INTDF.OUT nnnnnnnn.OUT
```

where **nnnnnnnn** is the unique file name of your INTDF input. A sample input file is located in Appendix A.

2.1.5 Level 1 User Interaction - DITTY Long-Term Calculations

Execution of DITTY is essentially as documented in Napier, Peloquin, and Strenge (1986), with the following exceptions:

- DITTY expects its input to be located in the file buffers as follows:

\GENII\DITTY.IN	-	Input file
\GENII\POP.IN	-	Population file
\GENII\JOINTFRE.IN	-	Joint frequency file (in format as provided on Hanford Data Supplementary Disk)
\GENII\AIRREL.IN	-	Air release input file
\GENII\WATREL.IN	-	Water release input file

- DITTY will place output in the file buffer named **\GENII\DITTY.OUT**.
- To execute DITTY, type the following commands:

```
COPY nnnnnnnn.IN \GENII\INTDF.IN
COPY mypop.IN \GENII\POP.IN
```

```
COPY myjf.IN \GENII\JOINTFRE.IN
COPY myair.IN \GENII\AIRREL.IN
COPY mywat.IN \GENIII\WATREL.IN
\GENII\DITTY
COPY \GENII\DITTY.OUT nnnnnnnn.OUT
```

where **nnnnnnnn** is the unique file name of your DITTY input, and **mypop**, **myjf**, **myair**, **mywat** are user-prepared files.

2.2 DATA TRANSFER FILE DESCRIPTIONS

The GENII package makes use of three basic types of data files: 1) data transfer files, 2) data libraries, and 3) working buffers. The data transfer files are used to input information to the codes and to transfer intermediate results from one code to the next. Data transfer files are described in this section. The data libraries are large static files of parameters necessary for the calculations, but with which the average user need not interact. The data libraries provided with GENII are described in Section 2.3. The working buffers are created and deleted during code execution, are transparent to the user, and are not described further.

2.2.1 ENVIN/ENV/DOSE Input File Buffer - GENII.IN

Program ENVIN expects to find an input file in the file buffer named GENII.IN. APPRENTICE handles transferring the user's input file into this file buffer. Consequently, use of this buffer is transparent to the Level 0 user. APPRENTICE writes an input file (named "nnnnnnnn.IN" where nnnnnnnn is a user-supplied name) for the user's scenario and stores the file in the default subdirectory. APPRENTICE also writes a batch file (named "nnnnnnnn.BAT", where nnnnnnnn is a user-supplied name) containing DOS (IBM 1985) commands to control execution of the programs. One of the commands in the batch file copies the user-named input file into GENII.IN in the \GENII subdirectory. GENII.IN is read by subroutine READIN of program ENVIN. The format of the file is constant with the exception of the inventory section, which may vary in length. See Section 3.2 for a detailed discussion on the format, preparation, and use of the input file.

2.2.2 Joint Frequency Input File Buffer - JOINTFRE.IN

Joint frequency meteorological data is read from the file buffer JOINTFRE.IN. The user is responsible for preparing joint frequency data in the file and record formats shown in Table 2.1. The file contains values representing the percent of time for persistence of each condition for specified numbers of wind speed groups, and atmospheric stability groups for 16 sectors. The grid sectors must correspond to the directions provided in the population input file buffer POP.IN. The formats shown in records 3 and 4 and in the joint frequency data sets are suggested; these records are processed with a free-formatted read statement. JOINTFRE.IN is read by

TABLE 2.1. Joint Frequency File and Record Format

Record Number	Field Number	Data Type	Field Size	Description
1	1	CHARACTER	80	Descriptive title
2	1	CHARACTER	80	(Not read by program. May contain additional descriptive and quality assurance data.)
3	1	INTEGER	5	Number of wind speed data groups in file
3	2	INTEGER	5	Number of atmospheric stability data groups in file
3	3	INTEGER	5	Number of seasons data groups in file (always one at this time)
3	4	INTEGER	5	Number of time-of-day data groups in file (always one at this time)
3	5	REAL	10	Height at which joint frequency data applies, m
4	1-10	REAL	7	Average wind speed for each windspeed group, m/sec
Joint Frequency Data Set				
1a	1-16	REAL	5	Percent of time for persistence of condition for directions into S, SSW, SW, ... (i.e., wind from N, NNE, NE ...)
:				
10a				(Each Joint Frequency Data Set contains data for 16 sectors [across]. Data are grouped first by atmospheric stability group and then by wind speed group.)

ACCMOD and CRONMOD in program ENVIN. An example of this file is shown with the sample problems in Appendix A of this report.

2.2.3 Chi/Q Input/Report File Buffer - CHIQ.IN

The user may request that Chi/Q values be generated from joint frequency data. If that is the case, the file buffer CHIQ.IN will contain the Chi/Q values generated upon completion of program ENVIN. Alternately, if known, the user may provide atmospheric dispersion factors as input in the file buffer CHIQ.IN. Options and file handling are controlled within APPRENTICE. ENV reads the Chi/Q values in CHIQ.IN and uses them to calculate air concentrations. If chronic exposure to a finite plume is considered, CHIQ.IN will also contain dose rate factors for each distance and direction of the grid for the six energy groups identified in Table 4.9 of Volume 1. Each data set consists of two identically formatted parts, the first for sector indices 1-8 (Wind toward: S-NNW) and the second for sector indices 9-16 (Wind toward: N-SSE). The file and record format as shown in Table 2.2 is based on the default number of distances (10).

TABLE 2.2. Chi/Q File and Record Format

Record Number	Field Number	Data Type	Field Size	Description
1	1	CHARACTER	80	Title of input file that created this file.
2	1	CHARACTER	80	(Not read by program. File creation date and time.)
3			80	(blank)
Chi/Q Data Set for Eight Sectors for Each of 10 Distances				
1a			7	(blank)
1a	1-8	INTEGER	9	Sector index, 1-8 or 9-16
2a			7	(blank)
2a	1-8	REAL	9	Effective wind speed (m/sec) for each sector indicated in data set record 1a
3a	1	REAL	7	Distance from source, m
3a	2-9	REAL	9	Chi/Q, m^3/sec, for sector indices 1-8 or 9-16, respectively
:				
12a				(One record for each distance)
13a			80	(blank)

TABLE 2.2. (contd)

Energy Group Dose Rate Factor Data Set - Six Data Sets (If Selected)

1b			7	(blank)
1b	1-8	INTEGER	9	Sector index, 1-8 or 9-16
2b	1	REAL	7	Distance from source, m
2b	2-9	REAL	9	Finite plume dose rate factor, (person rem dis/Ci MeV) for sector indices 1-8, or 9-16, respectively
:				
11b				(One record for each distance)
12b			80	(blank)

D/Q Data Set for Eight Sectors for Each of 10 Distances

1c			7	(blank)
1c	1-8	INTEGER	9	Sector index, 1-8 or 9-16
2c	1	REAL	7	Distance from source, m
2c	2-9	REAL	9	Normalized deposition factor, m^2/sec, for sector indices 1-8, or 9-16, respectively
:				
11c				(One record for each distance)
12c			80	(blank)

2.2.4 Population Grid Input File Buffer - POP.IN

Population distribution information is read from the file buffer named POP.IN. The grid used for population must correspond to the grid used for joint frequency and Chi/Q data. The file format is shown in Table 2.3. If DITTY population specification for chronic airborne releases Method Three is used, (see Section 3.5.1), population data sets should be stacked consecutively in the file for each time, T, specified in NAMELIST INPUT.

TABLE 2.3. Population File and Record Format

Record Number	Field Number	Data Type	Field Size	Description
1	1	CHARACTER	80	Title
2	1	CHARACTER	80	(Not read by program. File creation date and time.)
3			80	(blank)

TABLE 2.3. (contd)

Population Data Set				
1a	1-10	INTEGER	8	Population for each distance for one sector
:				
16a				(One record for each sector starting with S)

2.2.5 Food Production Grid Input File Buffer - FOODPROD.IN

If a food production distribution is to be used for the ingestion population, option 3 (see Section 3.1 Line 115+M to 116+M) food distribution is read from the file buffer named FOODPROD.IN. A data set is read for each selected food type, terrestrial food types first followed by animal products, for each of the 10 x 16 grid points. Table 2.4 shows the file and record format for the food distribution file. FOODPROD.IN is read by module XQIN in program ENVIN.

TABLE 2.4. Food Distribution File and Record Format

Record Number	Field Number	Data Type	Field Size	Description
1	1	CHARACTER	80	Title
2	1	CHARACTER	80	(Not read by program. File creation date and time.)
3			80	(blank)
Food Distribution Data Set for Each Selected Food Type				
1a	1-10	REAL	8	Food production for each grid point, kg/yr, for each of 10 distances
:				
16a				(One record for each sector starting with S)

2.2.6 Parameter Default Value Input File - DEFAULT.IN

The user has the option of changing most default parameters used in GENII. Those parameters not included in the input file because they are infrequently changed are read from the file DEFAULT.IN. The user may edit

DEFAULT.IN with a standard text editor. It is recommended, if changes are made to DEFAULT.IN, that the title line (first line of the file) be changed for QA purposes. However, all changes from default parameter values will be noted in the output file. The parameter name, previous default value, and modified value will be listed. DEFAULT.IN is processed with free-formatted read statements and includes descriptive information and units to simplify modifications. The distribution version of the DEFAULT.IN is shown in Volume 3, Section 5.2.

2.2.7 ENV Input File Buffer - ENV.IN

Program ENVIN reads the user's input file, performs validity checks on the user's scenario, reads necessary library data, writes the input parameter report, and then writes a cryptic file of parameter values into the file buffer ENV.IN. Scenario-specific parameters are written first, followed by radionuclide-specific parameters organized into decay chains. ENV.IN is subsequently read by ENV. ENV.IN is written by subroutine RITENV and read by subroutines REDCAS and REDCHA. Use of this file is transparent to the user.

2.2.8 INTDF Input File Buffer - INTDF.IN

The INTDF input file is read from the file buffer INTDF.IN. The user is responsible for copying INTDF input files into this buffer in the \GENII subdirectory. Level 1 users may interact with the INTDF internal dosimetry computer program by creating a free-formatted input file. See the input preparation instructions in Section 3.4 for details.

2.2.9 DITTY Input File Buffer - DITTY.IN

The DITTY input file is read from the file buffer named DITTY.IN. The user is responsible for copying DITTY input files into this buffer in the \GENII subdirectory. Information on preparing this file is included with the user instructions in Section 3.5. DITTY.IN is read by subroutine CASE2.

2.2.10 DITTY Water Release Input File Buffer - WATREL.IN

In DITTY, when waterborne releases are to be read from the water release input buffer (IWAT > 0 and LUW $\neq$ 1), a file should be prepared in the format shown in Table 2.5. The first two records, title and number of data sets, are followed by a data set for each radionuclide.

TABLE 2.5. Activity Release Data File and Record Format

Record Number	Field Number	Data Type	Field Size	Description
1	1	CHARACTER	80	Title
2	1	INTEGER	5	Number of radionuclides that activity release data are supplied for
Radionuclide Release Data Set				
1a	1	CHARACTER	2	Element symbol for the current radionuclide
1a	2	CHARACTER	6	Atomic weight symbol for the current radionuclide
1a			2	(blank)
1a	3	INTEGER	5	Number of times for which release data will be supplied, $\leq$ 300. This parameter, NT, determines the number of records in the radionuclide data set.
2a	1	REAL	10	Time at which the current release rate is defined; years since start of release based on input parameter TZR (see Section 3.5). Parameter: TA(i).
2a	2	REAL	10	Release rate, Ci/yr, for the current radionuclide at time TA(i). Read in double precision and converted to single precision.
:				
NT				There are NT data records for each radionuclide.

2.2.11 DITTY Air Release Input File Buffer - AIRREL.IN

In DITTY, when airborne releases are to be read from the air release input buffer (IAIR > 0 and LUA $\neq$ 1), a file should be prepared in the format shown in Table 2.5. The first two records, title and number of data sets, are followed by a data set for each radionuclide.

2.2.12 EXTDF Input File Buffer - EXTDF.IN

The EXTDF input file is read from the file buffer named EXTDF.IN. The user is responsible for copying EXTDF input files into this buffer in the \GENII subdirectory. Information on preparing this file is included with the user instructions in Section 3.3. EXTDF.IN is read by module EXTDF.

2.2.13 ENV Report File Buffer - GENII2.OUT

For some scenarios, information is written to the report file buffer named GENII2.OUT during ENV execution. The APPRENTICE-generated batch-process file contains a command to copy the contents of this file buffer, along with the file buffers named GENII.OUT and DOSE.OUT to create the user's report file. GENII2.OUT is written by module XQCAL.

2.2.14 ENVIN Report File Buffer - GENII.OUT

The APPRENTICE-generated batch-process file that controls ENVIN/ENV/DOSE execution contains a command to copy the contents of the file buffer named GENII.OUT, along with the file buffers GENII2.OUT and DOSE.OUT, to a user-named report file. GENII.OUT contains the portion of the report written by the program ENVIN (in subroutine RITQA), namely the input parameter report. In general, only parameters used by the given scenario are included in the report.

2.2.15 DOSE Report File Buffer - DOSE.OUT

Dose results are written to the file buffer DOSE.OUT by the subroutines DOSSUM, RITBYR, RITBYP, and RITEDE. The reports to be written are selected by the user in APPRENTICE. The minimal set of reports includes the following:

- a one-page report showing the committed (CDE) and weighted (WDE) dose equivalent by organ, the effective dose equivalent (EDE), external dose, and annual effective dose equivalent (AEDE) for the given scenario. The controlling organ, exposure pathway, and radionuclide for the scenario are identified. The inhalation EDE and ingestion EDE are also listed.

- a one-page matrix report showing the dose components and their additive interrelationships for the first three years of the dose commitment period. This report is included to aid the user in understanding the dose terminology.

- a report by radionuclide of the following doses: inhalation EDE, ingestion EDE, external dose, internal EDE, and AEDE.

In addition, the user may request reports of CDE by exposure pathway, CDE by radionuclide, and external dose by exposure pathway. The contents of DOSE.OUT including the input parameter report are written to the user-named output file. Sample problem reports, in Volume 2 Appendix A, provide examples of the various reports available.

2.2.16 ENV Media Concentration Report File Buffer - MEDIA.OUT

Media concentrations are not part of the GENII standard output. However this information is available to the Level 1 user in the file buffer MEDIA.OUT. For chronic exposure scenarios the residential air, surface soil, deep soil, ground water, and irrigation surface water concentrations are shown for each radionuclide for each year of the exposure period. The surface water concentration at the source is also shown. For acute exposures, the residential average population-weighted air concentration and surface soil concentration, as well as the time-integrated surface water concentration, are shown for each radionuclide for each year of the exposure period for each of the four seasons. It is the user's responsibility to store the contents of MEDIA.OUT under a unique file name at the completion of each scenario. An example of MEDIA.OUT is shown with the sample problems in Volume 2, Appendix A.

2.2.17 DOSE Summary Dose Report File Buffer - DOSEQA.OUT

The ENVIN/ENV/DOSE sequence is frequently used in applications that require several executions of the code. When this occurs, it is useful to have summary information available for preliminary results-checking, QA recording, and report generation. With each execution of DOSE, the file buffer named DOSEQA.OUT is appended with a one-line summary record. Table 2.6 describes each field in the summary record. This file can be copied and erased at will. It is efficient to delete the file from time to time, otherwise the file may become quite large. This report is written by module DOSSUM of program DOSE.

TABLE 2.6. Summary Dose Report Record Format

Field Number	Data Type	Field Size	Description
1	CHARACTER	18	First 18 characters of the scenario title
		1	Colon as title delimiter
2	REAL	8	Effective dose equivalent from inhalation
3	REAL	8	Effective dose equivalent from ingestion
4	REAL	8	External Dose
5	REAL	8	Effective dose equivalent
6	REAL	8	Annual effective dose equivalent
7	CHARACTER	4	Dose units: rem or Sv for individual, Prem or PSv for person-rem or person-Sv
8	CHARACTER	3	Flag for organ receiving largest commitment. Flag consists of first three letters of organ name.
9	CHARACTER	3	Flag indicating environmental pathways providing largest dose contribution. Flags are: "Inh" for inhalation, "Ing" for ingestion, and "Ext" for external.
10	CHARACTER	6	Radionuclide providing largest dose contribution
11	CHARACTER	8	Date of execution
12	CHARACTER	8	Time of execution
13	CHARACTER	1	"T" if near-field scenario, "F" if far-field scenario
14	CHARACTER	1	"T" if acute exposure, "F" if chronic exposure
15	CHARACTER	1	"T" if population dose, "F" if individual dose
		1	(blank)
16	CHARACTER	24	"T" if each of environmental exposure pathways is considered, "F" if not. The environmental pathways listed in order are: 1 - external exposure from plume 2 - inhalation uptake 3 - external exposure from ground 4 - leafy vegetable ingestion 5 - root vegetable ingestion 6 - grain ingestion 7 - fruit ingestion 8 - meat ingestion 9 - poultry ingestion 10 - cow milk ingestion 11 - egg ingestion 12 - inadvertent soil ingestion 13 - water ingestion while swimming 14 - external exposure from swimming 15 - external exposure from boating 16 - external exposure from shoreline activities 17 - drinking water ingestion 18 - fish ingestion 19 - mollusk ingestion 20 - crustacea ingestion 21 - aquatic plant ingestion

TABLE 2.6. (contd)

			22 - external exposure from deep soil
			23 - external exposure from buried waste
			24 - (unused)
17	INTEGER	2	Length of intake (yr)
18	INTEGER	2	Length of release (yr)
19	INTEGER	2	Length of dose commitment period (yr)

2.2.18 ENV Output File Buffer - ENV.OUT

Program ENV writes yearly environmental exposure rates by pathway and radionuclide to the output file buffer ENV.OUT in subroutine RITEXP. The file is subsequently read by DOSE in subroutine DOSCTL. Use of this file is transparent to the user.

2.2.19 INTDF Report File Buffer - INTDF.OUT

INTDF.OUT contains the report generated by the INTDF program. The file consists of the following reports for each radionuclide chain:

- input and program-assigned parameter report
- optional report (if detailed report flag has been set "on" in the input file) of SEE factors for each radionuclide
- the number of nuclear transformations over the given time period in the source organs and tissues, oral and inhalation, for each radionuclide chain member
- CDE for the given time period in target organs and tissues, oral and inhalation
- statistics detailing the amount of computational work performed by the LSODES solver.

It is the user's responsibility to save the output of this file buffer under a unique name. The file is written by the subroutines RITINT and RITEND. The report for Sample Problem 5, shown in Appendix A, is an example of this report.

2.2.20 INTDF CDE Yearly Increment File Buffer - CDEINC.OUT

CDE yearly increments are written to the file CDEINC.OUT. Use of this file is transparent to the user. The output from this file is used to generate the internal dose factor library, DOSINC.OUT, that is used by program DOSE to calculate doses. The file contains data sets for each radionuclide considered in the execution organized as follows in Table 2.7.

TABLE 2.7. CDE Yearly Increment File and Record Format

Record Number	Field Number	Data Type	Field Size	Description
1	1	CHARACTER	1	Exclamation point. Indicates beginning of radionuclide data set.
1			1	(blank)
1	2	CHARACTER	2	Alphabetical element symbol as specified in the radionuclide master library
1	3	CHARACTER	6	Atomic weight and possible metastable designation as specified in the radionuclide master library
1	4	CHARACTER	8	Inhalation classification used in calculations as defined above. Included for QA.
1	5	CHARACTER	14	F_1 value used in calculations. Included for QA.
1	6	CHARACTER	13	Date of calculation. Included for QA.
1	7	CHARACTER	12	Time of calculation. Included for QA.
1			3	(blank)
1	8	CHARACTER	7	Type of exposure, either acute or chronic. Included for QA.
1	9	CHARACTER	8	Dose units. Included for file readability and QA.
2	1	INTEGER	3	Number of organs considered. Parameter: NORG
2	2-26	INTEGER	3	Organ index of each organ considered as specified in the master organ list
3	1-25	INTEGER	3	Number of years for which ingestion dose increments are supplied for each organ specified in record #2

TABLE 2.7. (contd)

Organ Data Sets for Ingestion:

1a	1	CHARACTER	1	Flag indicating ingestion ("G"). Included for file readability.
1a	2-16	REAL	8	Yearly ingestion dose increment starting with the first year of exposure for this organ, Sv/Bq or Sv/Bq-yr
2a			1	(blank)
2a	2a-15	REAL	8	Yearly ingestion dose increment as defined above
:				
n				As needed for the number of years of data for this organ as identified in record 3

Organ Data Subsets for Inhalation:

1b	1	CHARACTER	1	Flag indicating inhalation ("H"). Included for file readability.
1b	2-16	REAL	8	Yearly inhalation dose increment starting with the first year of exposure for this organ, Sv/Bq or Sv/Bq-yr
2b			1	(blank)
2b	1-15	REAL	8	Yearly inhalation dose increment as defined above
:				
n				As needed for the number of years of data for this organ as identified in record 3

This file is written by subroutine RITINC. For an example of this file format, see the listing of the file DOSINC.OUT in Section 5.2 of Volume 3.

2.2.21 INTDF CDE File Buffer - CDE.OUT

Committed dose equivalent data sets are output in a form useful for library generation in the file CDE.OUT Output from this file was used to create the DITTY internal dose factor library DSFCT30.DAT. A data set for each radionuclide considered is generated in the following format in Table 2.8.

TABLE 2.8. CDE File and Record Format

Record Number	Field Number	Data Type	Field Size	Description
1	1	CHARACTER	2	Alphabetical element symbol as specified in the radionuclide master library
1	2	CHARACTER	6	Atomic weight, also metastable (m) designation
			7	(descriptive information)
1	3	CHARACTER	1	Translocation classification as described under RMDLIB.DAT
1			5	(descriptive information)
1	4	REAL	9	F_1 value used to calculate result. Included for QA.
1			5	(blank)
1	5	CHARACTER	10	Date of calculation. Included for QA.
1	6	CHARACTER	10	Time of calculation. Included for QA.
1	7	CHARACTER	10	Type of exposure, acute or chronic. Included for readability and QA.
1	8	CHARACTER	10	Units of result. Included for readability and QA.
2	1	INTEGER	3	Number of organs for which data is included for this radionuclide
2	2-n	INTEGER	3	Master organ index of each organ considered
3			5	(blank)
3	1-n	CHARACTER	8	Descriptive title of each organ as ordered in Record 2. Included for readability.
4	1	CHARACTER	1	Flag indicating dose factor type: "G" for ingestion. Included for readability.
4	2	INTEGER	3	Number of years in the dose commitment period. Included for QA and readability.
4	3-n	REAL	8	Ingestion committed dose equivalent, units as shown in Record 1 for each organ as ordered in Record 2.
5	1	CHARACTER	1	Flag indicating dose factor type: "H" for inhalation. Included for readability.
5	2	INTEGER	3	Number of years in the dose commitment period. Included for QA and readability.
5	3-n	REAL	8	Inhalation committed dose equivalent, units as shown in Record 1 for each organ as ordered in Record 2

2.2.22 DITTY Report File Buffer - DITTY.OUT

The input parameter report and dose results of program DITTY are written to the output file buffer DITTY.OUT. It is the user's responsibility to store the contents of the file buffer under a unique file name. DITTY.OUT is written by modules QAPAGE and REPORT. An example of this file is the output from Sample Problem 7, found in Appendix A.

2.2.23 DITTY Summary Dose Report File Buffer - DITTYQA.OUT

DITTY is frequently used in applications that require several executions of the code. When this occurs, it is useful to have summary information available for preliminary results-checking, QA recording, and report generating. With each execution of DITTY, the file buffer named DITTYQA.OUT is appended with a one line summary record. Table 2.9 describes each field in the summary record. This file can be copied and erased at will. It is efficient to delete the file from time to time, otherwise the file may become quite large. This report is written by module REPORT.

TABLE 2.9. DITTY Summary Dose Report Record Format

Field Number	Data Type	Field Size	Description
1	CHARACTER	18	First 18 characters of the scenario title
		1	Colon as title delimiter
2	REAL	8	Cumulative population dose equivalent received by population over the 10,000-yr period
3	CHARACTER	4	Unit flag for preceding dose, "Prem" indicating person-rem
4	CHARACTER	6	Radionuclide providing largest contribution to population dose
6	INTEGER	3	Index of 70-yr period in which highest population dose increment was received
7	REAL	8	Maximum individual dose
8	CHARACTER	4	Units for preceding dose
9	CHARACTER	6	Radionuclide providing largest contribution to individual dose
10	INTEGER	3	Index of 70-yr period in which maximum individual dose was received
11	INTEGER	5	Year of scenario in which maximum individual dose was received
12	CHARACTER	8	Date of execution
13	CHARACTER	8	Time of execution

2.2.24 EXTDF Report File Buffer - EXTDF.OUT

The file buffer named EXTDF.OUT is used to store the report file from EXTDF executions. Input parameter values are printed as are selected output units. Dose factors are printed in a format that simplifies library generation. EXTDF.OUT is written by modules EXTDF and SHORT. It is the user's responsibility to store the contents of the file under a unique file name.

2.3 DATA LIBRARY DESCRIPTIONS

The data files that provide tabulated values of constants for the calculations are described in this section.

2.3.1 Radionuclide Master Library - RMDLIB.DAT

The radionuclide master data library (RMDLIB.DAT) contains all radiological decay data in addition to the specification of all radionuclides for which data is included in the GENII Software System. The radionuclides are organized into decay chains ordered by atomic number under the radionuclides highest in the chain. RMDLIB.DAT is read by subroutine RLIBIN and is used by programs ENVIN, DITTY, INTDF, and EXTDF. Calculations of radioactive decay and daughter ingrowth are performed in the subroutines CHAIN and DGCHAIN, using the decay chain data of RMDLIB.DAT and the decay equations of Bateman (1910). RMDLIB currently contains information on 245 radionuclides.

RMDLIB contains one record for each radionuclide plus a header record and a trailer record. The header record contains the file title (FORTRAN format: A80) and a blank trailer record. The balance of the records contain information as shown in Table 2.10.

TABLE 2.10. Radionuclide Master Library Record Structure

Field Number	Data Type	Field Size	Description
1	CHARACTER	2	Alphabetical element symbol. Parameter: ELTM
2	CHARACTER	6	Atomic weight, also metastable (m) designation. Parameter: AWM
3	REAL	10	Radiological half-life, days. Parameter: TR
4	INTEGER	2	Indicator of relative position in decay chain (1 is highest position)
5	INTEGER	2	Indicator of precursor in decay chain (as identified in column 4 of the precursor, zero indicates no precursors). Parameter: IFR
6	REAL	7	Branching ratio for primary precursor. Parameter: DKF
7	INTEGER	2	Indicator of alternate precursor in decay chain. Parameter: IFR
8	REAL	7	Branching ratio for alternate precursor. Parameter: DKF
9	INTEGER	4	Atomic number. Parameter: ATNO
		1	(blank)
10	CHARACTER	1	Special-purpose flag used for research applications, input as a character field to set logical flag, used by EXTDF
11	INTEGER	2	Applicable internal dosimetry model used by INTDF where: 0-use General Model, 1-use Alkaline Earth Model, 2-use Iodine Model. Parameter: IMODM
		1	(blank)
12	CHARACTER	1	Flag indicating whether radionuclide is a bone-volume seeker (V), bone-surface seeker (S), or not applicable (N). Parameter: BONED
13	CHARACTER	1	Translocation classification. Parameter: TCLASS
14	INTEGER	2	Number of implicit daughters built into radionuclide. Parameter: NDAU
15-17			First implicit daughter data set
:			:
36-38			Eighth implicit daughter data set

Each implicit daughter data set consists of three columns containing the alphabetical element symbol, atomic weight plus metastable designation, and branching ratio as specified in fields 1, 2, and 6, respectively. The associated parameter name for the branching ratio is BRANCH.

Translocation refers to the rate at which radionuclides are transported by body fluids from the lungs to the blood and GI tract after inhalation (sometimes referred to as inhalation class or solubility class). For inhalation calculations, translocation classifications are made for each organ based on the usage of the Task Group Lung Model (ICRP 1966). The translocation flags used in RMDLIB.DAT refer to the following classes as defined by the ICRP (1966):

D - Class D Materials:	A maximum clearance time of less than a day
W - Class W Materials:	A maximum clearance time of a few days to a few months
Y - Class Y Materials:	A maximum clearance half time of six months to a few years.

Columns 1-14 are read with the FORTRAN format (A2, A6, E10.2, I2, 2(I2, F7.4), I4, 1X, A1, 1X, I1, 1X, 2A1, I2). If the number of implicit daughters is greater than 0, the record is reread with the FORTRAN format (52X, 8(A2,A6, F5.3, 1X)). RMDLIB.DAT is listed in Volume 3, Section 5.2.

2.3.2 Metabolic Data Library - METADATA.DAT

Johnson's (Johnson and Carver 1981, Johnson and Myers 1981) metabolic data library has been modified and expanded for use with the INTDF internal dosimetry program. The adult metabolic data is taken from ICRP 30 (1979a, 1980, 1981b) with minor exceptions. The library contains adult and infant data on uptake by blood, f_1 values for each inhalation class, distribution and retention in organs, as well as fraction of excretion via urine and feces. Excretion data is not used in INTDF.

The file consists of a header record containing title information and data sets for each element, adult or infant. Each data set contains three data records followed by up to four organ data subsets, followed by a single record indicating the end of the data set. Each of the organ data subsets consists of four records each, one record for each biological half time (organ/tissue sub-compartment). The last organ data subset is for remaining tissues/organs, classified as "OTHER." Organ data sets for the Alkaline Earth Model are ordered more stringently. Alkaline Earth Model data subsets are ordered as trabecular/cancellous bone, cortical bone, and bone surface, followed by "OTHER". The file format is shown in Table 2.11.

TABLE 2.11. Metabolic Data Set Record Format

Record Number	Field Number	Data Type	Field Size	Description
1	1	INTEGER	3	Atomic number of element
2	1	CHARACTER	14	Descriptive name of element, not used by program
2			1	(blank)
2	2	CHARACTER	1	Age indicator, A-Adult and I-Infant (Only adult information is processed in this version of INTDF.)
2			7	(blank)
2	3	REAL	5	Biological rate constant for the transfer compartment (blood and body fluids), d^{-1} Parameter: RTBLOOD
2	4	REAL	5	Fraction of excretion from blood via urine, (not used by INTDF)
2	5	REAL	5	Fraction of excretion from blood via feces, (not used by INTDF)
3	1	REAL	n	F_1 value for Inhalation Class D material
3	2	REAL	n	F_1 value for Inhalation Class W material
3	3	REAL	n	F_1 value for Inhalation Class Y material

Alkaline Earth Model Organ/Tissue Subset

Record Number	Field Number	Data Type	Field Size	Description
1a			1	(blank)
1a	1	CHARACTER	8	Bone compartment name, ("BONE CAN", "BONE COR", or "BONE SUR") or "OTHER"
1a			1	(blank)
1a	2	REAL	10	Fraction of material going from transfer compartment to each bone or OTHER sub-compartment. Parameter: TCBONE or TCOTHR
1a	3	REAL	10	Biological rate constant for each bone or OTHER sub-compartment, d^{-1}. Parameter: RTBONE or RTOTHR
1a	4	REAL	10	Fraction of material excreted via urine, (not used by INTDF)
1a	5	REAL	10	Fraction of material excreted via feces, (not used by INTDF)
:				
4a				One record for each of four sub-compartments

TABLE 2.11. (contd)

All Other Models Subset

1b		1		(blank)
1b	1	CHARACTER	8	Organ name as specified in the master organ list
1b			1	(blank)
1b	2	REAL	10	Fraction of material going from transfer compartment to each organ/tissue sub-compartment. Parameter: TCBONE, TCORG, or TCOTHR
1b	3	REAL	10	Biological rate constant for each organ/tissue sub-compartment, d^{-1}. Parameter: RTBONE, RTORG, or RTOTHR
1b	4	REAL	10	Fraction of material excreted via urine, (not used by INTDF)
1b	5	REAL	10	Fraction of material excreted via feces, (not used by INTDF)
:				
4b				One record for each of four sub-compartments.

Last Record

4			1	(blank)
4	1	CHARACTER	8	"END "

Record 1 is read in subroutine METLIB with the FORTRAN format (A14, 1X, A1, 7X, 3F5.3). Record 2 is processed with a free-formatted read. Each organ/tissue sub-compartment record is read as (1X, A8, 1X, 4E10.3). METADATA.DAT is listed in Volume 3, Section 5.2.

2.3.3 Radionuclide List By Atomic Number - RMDBYELE.DAT

To simplify scenario construction in APPRENTICE, radionuclides are displayed sorted by atomic number and mass number. The file RMDBYELE.DAT is a sorted list of radionuclides included in the master radionuclide library. The file consists of a header record with title information followed by records consisting of the two-character alphabetic symbol followed by the six-character atomic weight and possible metastable designation. RMDBYELE.DAT is read by BASIC subroutine MENU5 and is listed in Volume 3, Section 5.2.

2.3.4 Food Transfer Library - FTRANS.DAT

The food transfer factor library, FTRANS.DAT, contains factors used in programs ENV and DITTY relating concentrations of elements in soil to concentrations in farm products grown on that soil, and relating concentrations in animal feed to concentrations in animal products. The library also contains air deposition velocities. Sources of these parameters are to be published in a separate document. The file consists of a header record with title information, a second record containing column headings for file readability (not processed by the programs), followed by a record for each element included in the radionuclide master. The record format for this file is shown in Table 2.12.

TABLE 2.12. Food Transfer Library Record Format

Field Number	Data Type	Field Size	Description
1	CHARACTER	2	Alphabetical element symbol as specified in the radionuclide master library
2	REAL	9	Elemental deposition velocity from air to ground, m/sec. Parameter: DPVLT, DPVL
3	REAL	9	Food transfer coefficient for leafy vegetables/fresh animal forage, pCi/g plant (dry) per pCi/g soil (dry). Parameter: BVIT(1,n)
4	REAL	9	Food transfer coefficient for root vegetables, pCi/g plant (dry) per pCi/g soil (dry). Parameter: BVIT(2,n)
5	REAL	9	Food transfer coefficient for grains/stored animal feed, pCi/g plant (dry) per pCi/g soil (dry). Parameter: BVIT(3,n)
6	REAL	9	Food transfer coefficient for fruit, pCi/g plant (dry) per pCi/g soil (dry). Parameter: BVIT(4,n)
7	REAL	9	Food transfer coefficient for beef, d/kg. Parameter: FMIT(1,n)
8	REAL	9	Food transfer coefficient for poultry, d/kg. Parameter: FMIT(2,n)
9	REAL	9	Food transfer coefficient for cow milk, d/L. Parameter: FMIT(3,n)
10	REAL	9	Food transfer coefficient for eggs, d/kg. Parameter: FMIT(4,n)
11	REAL	9	Leaching rate (percolation) of radionuclides out of the surface soil layer (top 15 cm), yr^{-1}. Parameter: LEACHT

The FORTRAN format for each record is (A2, 9E9.2). FTRANS.DAT is read and dry plant weights are converted to wet weights in subroutines ENVLIB and FOOLIN. A listing of the file is included in Volume 3, Section 5.2.

2.3.5 Bioaccumulation Library - BIOAC1.DAT

The bioaccumulation library, BIOAC1.DAT, contains the factors used by ENV and DITTY to relate the concentration of radionuclides in aquatic biota to the concentration of radionuclides in the water. There are separate factors for fresh and salt water. Also included are factors representing the fraction of chemical elements passing through conventional municipal water treatment plants. These parameters and their selection processes will be documented in a separate report. The file consists of a header record with title information, a second record containing column headings for file readability (not processed by the programs), followed by a record for each element included in the radionuclide master library. The record format for this file is shown in Table 2.13.

TABLE 2.13. Bioaccumulation Library Record Format

Field Number	Data Type	Field Size	Description
1	CHARACTER	2	Alphabetical symbol as specified in the master radionuclide library
2	REAL	9	Bioaccumulation factor for fish in salt water, pCi/kg per pCi/L. Parameter: BIOACT(1,n)
3	REAL	9	Bioaccumulation factor for mollusk in salt water, pCi/kg per pCi/L. Parameter: BIOACT(2,n)
4	REAL	9	Bioaccumulation factor for crustacea in salt water, pCi/kg per pCi/L. Parameter: BIOACT(3,n)
5	REAL	9	Bioaccumulation factor for aquatic plants in salt water, pCi/kg per pCi/L. Parameter: BIOACT(4,n)
6	REAL	9	Bioaccumulation factor for fish in fresh water, pCi/kg per pCi/L. Parameter: BIOACT(1,n)
7	REAL	9	Bioaccumulation factor for mollusk in fresh water, pCi/kg per pCi/L. Parameter: BIOACT(2,n)
8	REAL	9	Bioaccumulation factor for crustacea in fresh water, pCi/kg per pCi/L. Parameter: BIOACT(3,n)
9	REAL	9	Bioaccumulation factor for aquatic plants in fresh water, pCi/kg per pCi/L. Parameter: BIOACT(4,n)
10	REAL	9	Drinking water clean-up factor, dimensionless. Parameter: DWCLET

The FORTRAN format for each record is (A2, 9E9.2). BIOAC1.DAT is read by subroutines ENVLIB and BIOLIN. A listing of the file is included in Volume 3, Section 5.1.

2.3.6 External Dose Factor Library - GRDF.DAT

External dose factors for air submersion, water surface, soil surface, deep soil and buried waste for each radionuclide specified in the master library are found in the file GRDF.DAT. Values in the library were calculated by the EXTDF program. All values are effective dose equivalent, calculated as the weighted sum of the organ doses.

GRDF.DAT is used by programs DOSE and DITTY. The file consists of a header record with title information, three records containing column headings for file readability (not processed by the programs), and followed by a record for each radionuclide included in the radionuclide master library in the format shown in Table 2.14.

TABLE 2.14. External Dose Factor Library Record Format

Field Number	Data Type	Field Size	Description
1	CHARACTER	2	Alphabetical element symbol as specified in the master radionuclide library
2	CHARACTER	6	Atomic weight plus possible metastable specification as included in the master radionuclide library
3	REAL	8	External dose factor for air immersion, Sv/yr per Bq/m^3. Parameter: DAIT
4	REAL	10	External dose factor at water surface, Sv/yr per Bq/L. Parameter: DBIT
5	REAL	10	External dose factor for the soil surface, Sv/yr per Bq/"m^3" to a depth of 15 cm. Input value is divided by 0.15 before storing in parameter DSIT.
6	REAL	10	External dose factor for deep soil or buried waste with a clean overburden of 15 cm, Sv/yr per Bq/m^3. Parameter: DDIT(n,1)
7	REAL	10	External dose factor for deep soil or buried waste with a clean overburden of 0.5 m, Sv/yr per Bq/m^3. Parameter: DDIT(n,2)
8	REAL	10	External dose factor for deep soil or buried waste with a clean overburden of 1.0 m, Sv/yr per Bq/m^3. Parameter: DDIT(n,3)
9	REAL	10	External dose factor for a plane surface, Sv/yr per Bq/m^2. Not used at this time.

The FORTRAN format for each record is (A2, A6, E8.2, 5E10.2). GRDF.DAT is read by subroutines REDFIL and GRDLIN. A listing of the file is included in Volume 3, Section 5.2.

2.3.7 Radioactive Decay Data for RMDLIB - ENERGY.DAT

Radioactive decay energies for the EXTDF program are read from a specialized version of DRALIST (Kocher 1981). The specialized file, named ENERGY.DAT, contains data sets for radionuclides as ordered in RMDLIB.DAT. Energies for implicit daughters, as identified in RMDLIB.DAT, have been added to the parent. Data set and record organization is the same as those of DRALIST. This file is read by module NRGLIB. ENERGY.DAT is listed in Volume 3, Section 5.2.

2.3.8 DITTY Internal Dose Factor Library - DSFCT30.DAT

Committed dose equivalents from chronic exposure for 70 years are stored in the file DSFCT30.DAT for use by DITTY. Data sets for this file are generated by INTDF. The library consists of a title record followed by a data set for each radionuclide included in RMDLIB.DAT. The format of the data sets are shown in Table 2.8. DSFCT30.DAT is listed in Volume 3, Section 5.2.

2.3.9 Attenuation Coefficients and Build-Up Factor Library - ISOLIB.DAT

EXTDF uses attenuation coefficients and build-up factors of the ISOSHLD (Engle 1966) program. This data is stored in the file named ISOLIB.DAT. Build-up factor coefficients are handled differently for energy groups 1 through 9 (0.01 to 0.1 MeV) and for groups 10 to 25 (0.1 to 3.2 MeV).

Attenuation coefficients are included for 20 common materials and are based on unit density. Mixed attenuation coefficients are calculated using Equation (4.2.3) of Volume 1. Each attenuation coefficient data set consists of three records containing data for 25 average group energies defined in Table 4.7 of Volume 1.

Build-up factors for energy groups 1 through 9 have been calculated using the "straight ahead" approximation. The build-up factors are tabulated for six atomic numbers (13, 26, 50, 74, 82, 92), five representative energies (0.01, 0.02, 0.05, 0.1, 0.2), and seven absorption mean free-path (μx) values

(1, 2, 4, 7, 10, 15, 20). Build-up factors for a particular solution are obtained by linear interpolation within this table.

The build-up factor library for groups 10 through 25 contains coefficients A, α_1, α_2 for the point isotopic source dose build-up factor [Taylor's formula (Rockwell 1956), Equation (4.2.4) in Volume 1]. These data are tabulated for seven materials: water, aluminum, iron, tin, tungsten, lead, and uranium (with effective atomic numbers 4, 13, 26, 50, 74, 82, and 92, respectively). The effective atomic number of a single shield region (in which build-up is considered characteristic of all shield regions) is used for interpolating in this library. Each build-up factor data sets consists of six records.

The file and record formats of ISOLIB.DAT are shown in Table 2.15. ISOLIB.DAT is listed in Volume 3, Section 5.2.

TABLE 2.15. ISOLIB.DAT File and Record Format

Record Number	Field Number	Data Type	Field Size	Description
1	1	CHARACTER	80	Title
Attenuation Coefficient Data Sets				
1a	1	CHARACTER	7	Material name (first record of data set only)
1a	2	INTEGER	2	Material number
1a	3	INTEGER	1	Data set record number (1, 2, or 3)
1a	4-12	REAL	7	Mass attenuation coefficient for nine energy levels
1a	13	REAL	3	Atomic number (first record of data set only)
1a	14	REAL	3	Atomic weight (first record of data set only)
Build-Up Factors for Energy Groups 10 Through 25 Data Sets				
1b			8	(Not read by program)
1b	1	INTEGER	1	Material number
1b	2	INTEGER	1	Data set record number
1b	3	REAL	7	Coefficients for eight energy groups: Records 1-2 A_1, Records 3-4 α_1, Records 5-6 α_2

TABLE 2.15. (contd)

1b	10	REAL	3	Atomic number
1b	11	INTEGER	1	Flag set to 1 if this is the last record of last data set of this type.

Build-Up Factors for Energy Groups One Through Nine Data Sets

1c	1	INTEGER	2	Atomic number
1c	2	INTEGER	2	First absorption mean free path value for which factors are given for five energies this record
1c	3	INTEGER	2	Second absorption mean free path value for which factors are given for five energies this record
1c	4-13	REAL	6	Build-up factors for five energies for absorption mean free paths as identified in fields 2 and 3

2.3.10 Committed Dose Equivalent Yearly Increment Library - DOSINC.DAT

Committed dose equivalent yearly increments are stored in binary form in the file named DOSINC.DAT. CDE yearly increment data sets for each radionuclide were generated with INTDF. The output from the file buffer named CDEINC.OUT was accumulated in the file buffer named DOSINC.OUT. A title line was added to DOSINC.OUT, and the utility program UNFORMAT was executed to generate the binary version of the file named DOSINC.DAT. Note that in the distribution package, the file DOSINC.OUT has been stripped of data, as only the title of the file is read from DOSINC.OUT during ENVIN/ENV/DOSE execution. Data set record formats are shown in Table 2.7. The text version of this file is shown in Volume 3, Section 5.2.

2.3.11 Gamma Energy Library - GAMEN.DAT

Finite plume calculations use energy per disintegration, (MeV/dis), for six energy groups for each radionuclide. The energy ranges of the six groups are shown in Table 4.9 of Volume 1. This information is stored in the file named GAMEN.DAT. The file is composed of a title record followed by records of the format shown in Table 2.16. The gamma energy library is read by module ENVLIB of program ENVIN. GAMEN.DAT is listed in Volume 3, Section 5.2.

TABLE 2.16. Gamma Energy Library Record Format

Field Number	Data Type	Field Size	Description
1	CHARACTER	2	Alphabetic element symbol as specified in the master radionuclide library
2	CHARACTER	6	Atomic weight plus possible metastable specification as included in the master radionuclide library
3-8	REAL	8	Energy per disintegration for six energy groups

2.3.12 Specific Effective Energy Library - SEEn.DAT

Specific effective energy data sets have been extracted from the ORNL data file (personal communication, Keith Eckerman) used to produce ICRP Publication 30 (1979a, 1979b, 1980, 1981a, 1981b, 1982a, 1982b) for radionuclides included in RMDLIB.DAT. Because of the volume of this data, the data has been split into three files and converted to an abbreviated (header and trailer records removed) binary format. SEE1.DAT consists of data sets for radionuclides with atomic numbers 1-43, SEE2.DAT of those with atomic numbers 44 through 80 and SEE3.DAT contains the remainder. The utility program UNSEE is used to create the binary version of the files.

2.4 EXTERNAL FILE NAME ASSIGNMENTS - FILENAME.DAT

GENII assigns each external file (data, input, or output) a unique logical unit number (LUN). All file names and there associated LUNs are transparent to the user; APPRENTICE generates the necessary commands to handle the user's input and output files. However, the experienced user in the course of research may wish to assign experimental data libraries. This is possible because all file names and LUNs are stored in the file named "FILENAME.DAT". GENII looks first in the users default directory for "FILENAME.DAT". If not found, the distribution version of the file stored in the GENII subdirectory is used. "FILENAME.DAT" consists of 49 records containing the file names for LUNs 2-50, ("FILENAME.DAT" is assigned in LUN 1). Each record contains the information shown in Table 2.17. The contents of the 49 records are shown in Table 2.18.

TABLE 2.17. File Name Assignments Record Structure

Field Number	Data Type	Field Size	Description
1	INTEGER	2	Logical unit number (Not read by the program, included for readability). Parameter: LUN
		8	(blank)
2	CHARACTER	30	File name, including drive specification and path. Parameter: FILN

The FORTRAN format for each record is (10X, A30). "FILENAME.DAT" is read by the subroutine OPNFIL and is used by all programs in the software package. A listing of "FILENAME.DAT" is shown in Volume 3, Section 5.2.

TABLE 2.18. Logical Unit Numbers, Default File Names, and Usage of External Files in the GENII Software Package

Logical Unit Number	Default File Name	File Usage
2	\GENII\RMDLIB.DAT	Radionuclide master library
3	\GENII\METADATA.DAT	Metabolic data library
4	\GENII\RMDBYELE.DAT	Radionuclide list sorted by atomic number and mass number
5	\GENII\GENII.IN	GENII input file buffer
6	\GENII\GENII.OUT	GENII report file buffer
7	\GENII\WORK.BUF	Work space used by various programs in the software package
8	\GENII\FTRANS.DAT	Food transfer library
9	\GENII\BIOAC1.DAT	Bioaccumulation library
10	\GENII\GRDF.DAT	External dose factor library
11	\GENII\ENV.IN	ENV input file buffer
12	\GENII\DOSSUM.DAT	Dose report format file
13	\GENII\ENV.OUT	ENV output file buffer
14	\GENII\DOSE.OUT	DOSE report file buffer
15	\GENII\INTDF.OUT	INTDF report file buffer
16	\GENII\CDEINC.OUT	Committed dose equivalent yearly increment INTDF output file
17	\GENII\DITTY.OUT	DITTY report file buffer
18	\GENII\INTDF.IN	INTDF input file buffer
19		unused
20	\GENII\CDE.OUT	Committed dose equivalent INTDF output file
21	\GENII\MEDIA.OUT	Air, water, and soil concentration report file buffer
22	\GENII\DEFAULT.IN	Parameter default value input file
23	\GENII\JOINTFRE.IN	Joint frequency input file buffer

TABLE 2.18. (contd)

24	\GENII\CHIQ.IN	Chi/Q input/output file buffer
25		unused
26	\GENII\ENERGY.DAT	DRALIST for RMDLIB with implicit daughters built into parent
27	\GENII\POP.IN	Population grid input file buffer
28	\GENII\GENII2.OUT	Second GENII report file buffer
29	\GENII\FOODPROD.IN	Food production grid input file buffer
30	\GENII\DSFCT30.DAT	DITTY internal dose factors
31	\GENII\WATREL.IN	DITTY water release input file buffer
32	\GENII\AIRREL.IN	DITTY air release input file buffer
33	\GENII\DITTY.IN	DITTY input file buffer
34	\GENII\ISOLIB.DAT	EXTDF ISOSHLD library
35	\GENII\EXTDF.IN	EXTDF input file buffer
36	\GENII\EXTDF.OUT	EXTDF report file buffer
37	\GENII\DOSINC.OUT	Text version of committed dose equivalent yearly increment file
38	\GENII\GAMEN.DAT	Gamma energies for each of 6 energy groups
39	\GENII\DOSEQA.OUT	Summary dose report/quality assurance log file
40	\GENII\DOSINC.DAT	Binary version of committed dose equivalent yearly increment file
41	\GENII\SEE.IN	Label format file for the utility program SEERPT
42		Unused
43		Unused
44	\GENII\SEERPT.OUT	Report file of the utility program SEERPT
45	\GENII\SEE1.DAT	Specific effective energies for radionuclides with mass numbers < 44
46	\GENII\SEE2.DAT	Specific effective energies for radionuclides with mass numbers > 43 and < 81
47	\GENII\SEE3.DAT	Specific effective energies for radionuclides with mass numbers > 80
48		Unused
49	\GENII\WORK2.BUF	Workspace used by various programs in the software package
50	\GENII\WORK3.BUF	Workspace used by various programs in the software package

3.0 USERS' INSTRUCTIONS

3.1 APPRENTICE

APPRENTICE is an interactive, menu-driven input generator for most applications of the GENII system. The code is largely self-documenting by means of numerous pull-down help screens. Description of the use of the code is therefore limited to general instructions. Detailed descriptions of the various options available in APPRENTICE are provided to the user as the code is used. General instructions on the use of APPRENTICE are:

1. Use left and right arrows on numeric keypad to move to another menu. There are 12 main menus in APPRENTICE. You will see only those menus that are appropriate for the scenario under construction.
2. Use down arrow on numeric keypad to pull a menu down.
3. Use return key to select an item.
4. Use the F1 key or select Help from the menu. Assistance is available throughout APPRENTICE by accessing pop-up help screens.
5. Use APPRENTICE to assist you with scenario construction in the following ways:
   - APPRENTICE checks for option incompatibilities and alerts you when these are discovered.
   - APPRENTICE asks questions pertinent only to the current scenario.
   - APPRENTICE provides default values for all variables. You may select between maximum individual and average individual parameters.
   - APPRENTICE checks all input variables against reasonable bounds.
6. Use APPRENTICE when scenario construction is complete to request a file name for storing your scenario. A GENII input file will be created with a file extension of ".IN". An execution file will be created with a ".BAT" extension.

7. Create multiple input files in an APPRENTICE execution if desired. Simply select "Another Scenario" after you have selected "Write file" on the final menu. APPRENTICE will return you to the first menu. All variable selections from the previous scenario remain in effect unless changed. A single execution file will be generated for processing the series of scenarios.

8. Exit APPRENTICE quickly without saving your scenario if desired. Simply press the Esc key several times until the final menu appears.

3.2 ENVIRONMENTAL DOSIMETRY PACKAGE: ENVIN/ENV/DOSE

The "main line" GENII programs are ENVIN, ENV, and DOSE. These three codes perform input checking and atmospheric dispersion calculations, environmental transport and exposure calculations, and dosimetry calculations, respectively. All calculations performed by these three codes are controlled by an input file named GENII.IN, which may be created by the user interface code APPRENTICE or directly by the user. An example of the GENII.IN file is presented as Exhibit 3.1. A line-by-line description of the parameters and options defined in GENII.IN is given in the paragraphs following the exhibit, with the code variable name in capital letters.

EXHIBIT 3.1. Example GENII.IN File

```
######################### Program GENII Input File ############  8 Jul 88 ####
Title: Demonstration Case for Example
       \GENII\exit.in                            Created on 09-09-1988 at 10:24
OPTIONS======================== Default ====================================
F    Near-field scenario?      (Far-field)    NEAR-FIELD: narrowly-focused
F    Population dose?         (Individual)                release, single site
F    Acute release?             (Chronic)     FAR-FIELD:  wide-scale release,
     Maximum Individual data set used                     multiple sites
                              Complete                                 Complete
TRANSPORT OPTIONS=========== Section   EXPOSURE PATHWAY OPTIONS===== Section
T  Air Transport                1      T  Finite plume, external       5
F  Surface Water Transport      2      F  Infinite plume, external     5
F  Biotic Transport (near-field) 3,4   T  Ground, external             5
F  Waste Form Degradation (near) 3,4   F  Recreation, external         5
                                       T  Inhalation uptake            5,6
REPORT OPTIONS=====================    F  Drinking water ingestion     7,8
T  Report AEDE only                    F  Aquatic foods ingestion      7,8
F  Report by radionuclide              T  Terrestrial foods ingestion  7,9
F  Report by exposure pathway          T  Animal product ingestion     7,10
F  Debug report on screen              F  Inadvertent soil ingestion

INVENTORY ##################################################################

 4   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 0   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

     --------|----Release Terms------|----------Basic Concentrations---------|
     Use when|  transport selected   |  near-field scenario, optionally      |
     --------|-----------------------|---------------------------------------|
     Release |        Surface Buried |        Surface Deep    Ground  Surface|
     Radio-  |Air     Water   Waste  |Air     Soil    Soil    Water   Water  |
     nuclide |/yr     /yr     /m3    |/L      /unit   /m3     /L      /L     |
     --------|------- ------- -------|------- ------- ------- ------- -------|
     SR90     5.0E-02
     I 131    3.0E+00
     CS137    1.0E-01

     --------|----Derived Concentrations-----|
     Use when|   measured values are known   |
     --------|-------------------------------|
     Release |Terres. Animal  Drink   Aquatic|
     Radio-  |Plant   Product Water   Food   |
     nuclide |/kg     /kg     /L      /kg    |
     --------|------- ------- ------- -------|

TIME #######################################################################

1    Intake ends after (yr)
50   Dose calc. ends after (yr)
1    Release ends after (yr)
0    No. of years of air deposition prior to the intake period
0    No. of years of irrigation water deposition prior to the intake period
```

```

FAR-FIELD SCENARIOS (IF POPULATION DOSE) #####################################

0           Definition option: 1-Use population grid in file POP.IN
0                              2-Use total entered on this line

NEAR-FIELD SCENARIOS #########################################################

            Prior to the beginning of the intake period: (yr)
0             When was the inventory disposed?  (Package degradation starts)
0             When was LOIC?  (Biotic transport starts)
0           Fraction of roots in upper soil (top 15 cm)
0           Fraction of roots in deep soil
0           Manual redistribution: deep soil/surface soil dilution factor
0           Source area for external dose modification factor (m2)
TRANSPORT ###################################################################
            ====AIR TRANSPORT===================================SECTION 1=====
                    0-Calculate PM          |0        Release type (0-3)
 2          Option: 1-Use chi/Q or PM value |T        Stack release (T/F)
                    2-Select MI dist & dir  |60.      Stack height (m)
                    3-Specify MI dist & dir |100.0    Stack flow (m3/sec)
0           Chi/Q or PM value               |5.0      Stack radius (m)
0           MI sector index (1=S)           |25.      Effluent temp. (C)
0           MI distance from release point (m)|0      Building x-section (m2)
T           Use jf data, (T/F) else chi/Q grid|0      Building height (m)

            ====SURFACE WATER TRANSPORT=========================SECTION 2=====
0           Mixing ratio model: 0-use value, 1-river, 2-lake
0           Mixing ratio, dimensionless
0           Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
0           Transit time to irrigation withdrawl location (hr)
            If mixing ratio model > 0:
0               Rate of effluent discharge to receiving water body (m3/s)
0               Longshore distance from release point to usage location (m)
0               Offshore distance to the water intake (m)
0               Average water depth in surface water body (m)
0               Average river width (m), MIXFLG=1 only
0               Depth of effluent discharge point to surface water (m), lake only

            ====WASTE FORM AVAILABILITY=========================SECTION 3=====
0                     Waste form/package half life, (yr)
0                     Waste thickness, (m)
0                     Depth of soil overburden, m

            ====BIOTIC TRANSPORT OF BURIED SOURCE===============SECTION 4=====
T           Consider during inventory decay/buildup period (T/F)?
T           Consider during intake period (T/F)?  | 1-Arid non agricultural
0           Pre-Intake site condition.............| 2-Humid non agricultural
                                                  | 3-Agricultural

EXPOSURE ####################################################################

            ====EXTERNAL EXPOSURE===============================SECTION 5=====
            Exposure time:            |  Residential irrigation:
```

```
      8766.0     Plume (hr)                     | T       Consider: (T/F)
      4380.0     Soil contamination (hr)        | 0       Source: 1-ground water
      0          Swimming (hr)                  |                 2-surface water
      0          Boating (hr)                   | 0       Application rate (in/yr)
      0          Shoreline activities (hr)      | 0       Duration (mo/yr)
      0        Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
      0        Transit time for release to reach aquatic recreation (hr)
      0        Average fraction of time submersed in acute cloud (hr/person hr)

               ====INHALATION=====================================SECTION 6=====
      8766.0   Hours of exposure to contamination per year
      0        0-No resus-  1-Use Mass Loading          2-Use Anspaugh model
      0          pension      Mass loading factor (g/m3)   Top soil available (cm)

               ====INGESTION POPULATION===========================SECTION 7=====
       1       Atmospheric production definition (select option):
      0          0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line
                 1-Use population-weighted chi/Q
                 2-Use uniform production
                 3-Use chi/Q and production grids (PRODUCTION will be overridden)
      0        Population ingesting aquatic foods, 0 defaults to total (person)
      0        Population ingesting drinking water, 0 defaults to total (person)
      F        Consider dose from food exported out of region (default=F)

               Note below: S* or Source: 0-none, 1-ground water, 2-surface water
                                         3-Derived concentration entered above
               ==== AQUATIC FOODS / DRINKING WATER INGESTION=========SECTION 8====

      F        Salt water? (default is fresh)

               USE         TRAN-  PROD-     -CONSUMPTION- |
               ?   FOOD    SIT    UCTION    HOLDUP  RATE  |
               T/F TYPE    hr     kg/yr     da      kg/yr |      DRINKING WATER
               --- ------- -----  -------   ------  ----- |-------------------------
               F   FISH    0.00   0.0E+00    0.00    0.0  | 0     Source (see above)
               F   MOLLUS  0.00   0.0E+00    0.00    0.0  | T     Treatment? T/F
               F   CRUSTA  0.00   0.0E+00    0.00    0.0  | 0     Holdup/transit(da)
               F   PLANTS  0.00   0.0E+00    0.00    0.0  | 0     Consumption (L/yr)

               ====TERRESTRIAL FOOD INGESTION=====================SECTION 9=====

               USE         GROW   --IRRIGATION--         PROD-     --CONSUMPTION--
               ?   FOOD    TIME   S RATE   TIME   YIELD  UCTION    HOLDUP   RATE
               T/F TYPE    da     * in/yr  mo/yr  kg/m2  kg/yr     da       kg/yr
               --- ------  -----  - -----  -----  -----  -------   ------   ------
               T   LEAF V  90.00  0   0.0    0.0    1.5  0.0E+00     1.0     30.0
               T   ROOT V  90.00  0   0.0    0.0    4.0  0.0E+00     5.0    220.0
               T   FRUIT   90.00  0   0.0    0.0    2.0  0.0E+00     5.0    330.0
               T   GRAIN   90.00  0   0.0    0.0    0.8  0.0E+00   180.0     80.0

               ====ANIMAL PRODUCTION CONSUMPTION==================SECTION 10====

               ---HUMAN---- TOTAL   DRINK   -------------STORED FEED--------------
      USE      CONSUMPTION  PROD-   WATER   DIET  GROW  -IRRIGATION--        STOR-
```

? T/F	FOOD TYPE	RATE kg/yr	HOLDUP da	UCTION kg/yr	CONTAM FRACT.	FRAC- TION	TIME da	S *	RATE in/yr	TIME mo/yr	YIELD kg/m3	AGE da
T	BEEF	80.0	15.0	0.00	0.00	0.00	90.0	0	0.0	0.00	0.80	180.0
T	POULTR	18.0	1.0	0.00	0.00	0.00	90.0	0	0.0	0.00	0.80	180.0
T	MILK	270.0	1.0	0.00	0.00	0.00	45.0	0	0.0	0.00	2.00	100.0
T	EGG	30.0	1.0	0.00	0.00	0.00	90.0	0	0.0	0.00	0.80	180.0
						-------------FRESH FORAGE-----------						
	BEEF					0.00	45.0	0	0.0	0.00	2.00	100.0
	MILK					0.00	30.0	0	0.0	0.00	1.50	0.0

```
###############################################################################
```

Line 1: The first line is a file identifier line for the GENII.IN file. Because the file is written by and read by formatted commands, changes to the basic format can result in the inability to transfer data. This line contains the date of the last revision to the formatting of this file. Should future changes to the codes require changes to the format of this input file, this date will indicate whether or not the file will be successfully read by ENVIN.

Line 2: This line is a title line for the specific input case, TITLS.

Line 3: This line provides the name of the specific input file created by APPRENTICE that was copied into GENII.IN. It also provides the date and time at which the file was created, INFILN.

Line 4: OPTIONS header line.

Line 5: Near-field or far-field scenario option flag, NEAR. A "scenario" is a conceptual model of patterns of human activity corresponding to actions, events, and processes that result in radiation exposure to individuals or groups. A "far-field" scenario is one defined to determine the impacts of a particular release of radioactive material into a wide environment, such as doses from releases from a stack to individuals or populations downwind. In a "near-field" scenario, focus is on possible doses to an individual at a particular location resulting from initial contamination or contaminated external sources, e.g., buried waste or contaminated soil. In a near-field scenario, contamination levels in specific environmental media may be known. A far-field scenario can be characterized as coming in to a receptor. Of course, the two types are not mutually exclusive - some doses to individuals from remote sources can be calculated as either far- or near-field with the same result. Specific examples of common types of far-field and near-field scenarios include:

CHRONIC ATMOSPHERIC RELEASE - prospective or retrospective doses to individuals or populations at specified distances and directions from the source, via submersion, inhalation, deposition groundshine, and food pathways. This class of scenario is commonly used for showing compliance with regulations that apply to emission sources.

ACUTE ATMOSPHERIC RELEASES - prospective or retrospective doses to individuals or populations at specified distances and directions from an acute release via submersion, inhalation, deposition groundshine, and food pathways. This class of scenario is often used in Safety Analysis Reports (SARs) or Environmental Impact Statements (EISs).

CHRONIC SURFACE WATER RELEASES - prospective or retrospective doses to individuals or populations at specified distances downstream of a release point via swimming, boating, shoreline exposure, drinking water, aquatic foods, irrigated terrestrial foods and animal products, soil contaminated from irrigation, and other pathways associated with liquid releases. This class of calculation is also often encountered in showing compliance with regulations.

ACUTE SURFACE WATER RELEASES - prospective or retrospective doses to individuals and populations at specified distances downstream of a release point via swimming, boating, shoreline exposure, drinking water, aquatic foods, irrigated terrestrial foods and animal products, soil contaminated from irrigation, and other pathways associated with acute liquid releases. This class of calculations is also associated with SARs and EISs.

INITIAL SURFACE CONTAMINATION - individual doses resulting from contact with contaminated soil or surfaces via direct contact, resuspension, or crop uptake. Calculations of this nature can be used to analyze the impacts of spills or remedial actions.

INITIAL SUBSURFACE CONTAMINATION - individual doses resulting from contact with contaminated soil or surfaces via direct contact, resuspension, or crop uptake. The surface soil may be contaminated via manual redistribution of the material or via biotic transport. Calculations of this nature can be used to analyze the impacts of waste management options. Often a time delay may be included to take into account the radioactive decay of the source.

GROUNDWATER CONTAMINATION - prospective or retrospective doses to individuals and populations from a given water concentration via irrigation and other pathways associated with liquid releases. This class of calculations is also often encountered when showing compliance with regulations.

CUMULATIVE EFFECTS - prospective calculations combining initial soil contamination with additional contributions from an external atmospheric or liquid source. This type of calculation is representative of how near-field and far-field calculations can conceptually be combined.

Line 6: Population or individual dose calculation flag, POPDOS. Scenarios may be constructed to calculate either doses to representative members of critical groups (individuals) or collective doses to regional populations or subpopulations. Note that individual doses may be calculated for either near-field or far-field scenarios but that population doses are defined for far-field scenarios (because locally-measured or locally-predicted values cannot be representative over wide areas).

Line 7: Acute or chronic release flag, ACUTE. For scenarios involving release of radioactive materials into the environment, the input may be either of short duration (a matter of minutes to a few days) or continuous or routine (such that annual average parameters are appropriate). Note that scenarios involving exposure to pre-existing soil, vegetation, or ground water contamination must be treated as chronic.

Line 8: This line contains a reminder of the type of individual exposure parameters used for inhalation, ingestion, and external exposure. Two sets of recommended default parameters are provided to ease data entry for the APPRENTICE code. The "Average Individual" set is representative of the population average exposure and dietary habits, and should be used for most population dose calculations. The "Maximum Individual" set provides upper bound parameters you may override. All default parameters may be overridden; however, they provide an adequate basis for most generic calculations.

If you find that you are regularly resetting particular parameters, you may revise the default parameter file by editing the PARAMS.DAT file accessed by APPRENTICE. The format of this file is described in Section 2.3.

Note: Only the first column of each of these lines 5, 6, and 7 is read, as a True or False logical variable. The remainder of the line is information to allow ease of editing and is not read by the ENVIN program. Similar structure is true of all the remaining lines of the GENII.IN file, i.e., only the fields necessary to transmit information are read.

Lines 9 and 10: Spacing and header lines for transport and exposure pathway options.

Line 11, Column 1: Atmospheric transport flag, AIR. In most calculations, the known quantity is generally the release quantity. This may take the form of activity, or activity per unit time, released into the transport media of air or surface water, or in the case of buried waste, into soil via waste package degradation and biotic transport. These are converted via appropriate models to concentrations in the corresponding media. The transport flags of lines 11 through 14 indicate which models are to be activated.

Line 12, Column 1: Surface water transport flag, SWAT.

Line 13, Column 1: Biotic transport flag (only activated for near-field scenarios with subsurface contamination), BIOT.

Line 14, Column 1: Waste form degradation flag (only activated for near-field scenarios with buried wastes), BURWAS.

Line 15, Column 1: A blank field.

Line 16, Column 1: The Report Options header.

Line 17, Column 1: Flag for type of dose calculation, OUTEDE. Various levels of detail are available in the output report. The Annual Effective Dose Equivalent (AEDE) is the committed dose from one year of exposure (Volume 1, Figure 3.2). If this option is not selected, cumulative doses (Volume 1, Figure 3.3 or 3.4) from continued exposure (for the number of years you specify in the TIMES menu) will also be calculated and reported. Additional information can be requested on AEDE and cumulative dose-by-radionuclide or dose-by-exposure-pathway as controlled by the flags on lines 18 and 19. Note that all of these options result in an increased number of pages of output.

Line 18, Column 1: Flag to provide report of exposure by radionuclide, OUTRAD.

Line 19, Column 1: Flag to provide report of exposure by pathway, OUTPTH.

Line 20, Column 1: Flag to provide debugging output, DEBUG. For users interested in the intermediate workings of the code, selected information can be displayed on the screen during calculations. This information is cryptic, fast-scrolling, and slows the calculations. Interpretation requires use of the code listings provided in Volume 3 of this PNL-6584 series.

Line 11, Column 2: Flag to activate finite plume external exposure pathway, FINITE. The potential routes through which people may be exposed to radionuclides or radiation are called "exposure pathways." The general pathways can be thought of as external exposure, inhalation, and ingestion. The flags in Column 2 of lines 11 through 20 control the pathways for which results are calculated. The pathways are chosen depending on the ways people can be exposed for a given circumstance. In this way, an appropriate collection of defined pathways can also be considered to be a definition of an "exposure scenario." Because the types of exposure must be conceptualized before the pathways can be fully defined, "scenarios" are usually defined before the parameters are selected for the "pathways."

Note that either the flag on line 11 or on line 12 can be true, but not both simultaneously. Also, note that the flag on line 11 can be true only if joint frequency data is to be input (the flag on the last line of the atmospheric transport options, described below).

Line 12, Column 2: Infinite plume external exposure flag, AIREXT.

Line 13, Column 2: Soil exposure external exposure flag, GROUND.

Line 14, Column 2: Aquatic recreation (swimming, boating, shoreline) exposure flag, RECRE.

Line 15, Column 2: Inhalation exposure flag, INHAL.

Line 16, Column 2: Drinking water ingestion exposure flag, DRINK.

Line 17, Column 2: Aquatic foods ingestion exposure flag, AQFOOD.

Line 18, Column 2: Terrestrial foods (crops) ingestion exposure flag, TFOOD.

Line 19, Column 2: Animal product (meat, milk, eggs) ingestion exposure flag, ANFOOD.

Line 20, Column 2: Inadvertent soil ingestion model exposure flag, SLING.

Line 21 to 23: Inventory editing header.

Line 24: Selection of radionuclide inventory activity units, IUNIT. GENII requires information on the source of radioactivity in order to continue. You have the option of using either SI units or the various multiples of conventional units. Note that if you are entering source term information for more than one environmental medium, the units used must be consistent within a single case.

Line 25: Selection of surface soil inventory units - the source may be entered in terms of area, volume, or mass, SOLUNT.

Line 26: Reserved line for future development work.

Lines 27 through 34: Inventory editing headers. "Release Terms" are sources to air or water or concentrations in buried wastes. "Basic Concentrations" may be calculated from the release terms, or if known may be entered and the transport steps omitted from the calculations. "Derived Concentrations," if known, may be entered and both the transport and environmental pathway calculations bypassed.

Lines 35 to 35+N: Inventories of radionuclides may be entered here for release or basic concentrations. If derived concentrations are to be used, line 35 may be left blank. Units are as defined on lines 24 and 25. Note that these are formatted reads; therefore the entries must be within the fields defined by the editing headers.

Lines 36+N to 42+N: Derived concentration editing header.

Lines 43+N to 43+M: Inventories of derived concentrations of radionuclides may be entered here. If only release terms and/or basic concentrations are to be used, line 43+N may be left blank. Again, these are formatted reads that must fall within the limits defined by the editing headers.

Lines 44+M to 45+M: Time editing header. The time step available for GENII simulations is integer-years. Within this constraint, scenarios may be constructed by defining the length of time a person is exposed (intake ends), the period for which the dose commitment is calculated (dose calculation ends), the length of time during which the individual(s) is/are exposed that the active radionuclide release continues, and the length of time before the beginning of the exposure that deposition via air or water occurred (for determining soil accumulation). Refer to Figure 3.1 for definition of the various time adjustments available.

Line 46+M: Length of time over which the intake occurs (time from "Intake Begins" to "Intake Ends" in Figure 3.1), NTKEND, yr. If the AEDE ONLY option has been selected for the reports, only one year will be used.

Line 47+M: Length of time over which dose calculation is integrated (time from "Intake Begins" to "Dose Calculation Ends" in Figure 3.1), DCEND, yr.

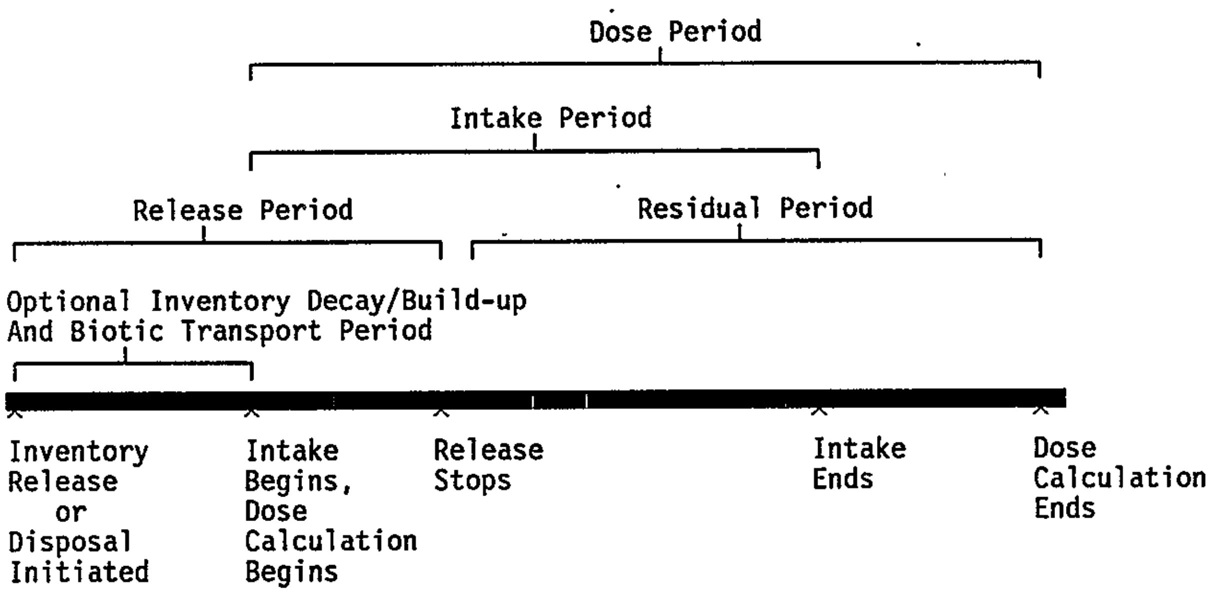


FIGURE 3.1. Time Line for Periods from Release of Radioactive Material Through Completion of Dose Calculations

Line 48+M: Length of time over which release occurs during exposure (time from "Intake Begins" to "Release Stops" in Figure 3.1), RELEND, yr. If the AEDE ONLY option has been selected for the reports, only one year will be used.

Line 49+M: Length of time prior to time "Intake Begins" that inventory atmospheric release was initiated (the early portion of the "Release Period" of Figure 3.1), BEFAIR, yr.

Line 50+M: Length of time prior to time "Intake Begins" that inventory surface water release and irrigation were initiated (the early portion of the "Release Period" of Figure 3.1), BEFIRR, yr.

Lines 51+M to 53+M: Far-field scenario parameter editing header.

Line 54+M: To calculate population doses, you will be asked to input consumption/exposure parameters for an average individual in the population. GENII will then use these average parameters times the number of people to calculate collective dose. The code can either figure a total population for you by summing from a grid that you must provide through input buffer POP.IN, or you can simply enter the total. This line defines whether the grid or the total will be used, POPOPT.

Line 55+M: If only the total population is being used, enter it on this line, POPIN, persons.

Line 56+M to 59+M: Near-field scenario editing header. If you have selected "Buried Waste or Deep Soil" as a source, radioactive decay of the source from the quantity initially disposed and release from waste packages to soil can be calculated by entering the appropriate decay time in the following lines. If "Buried Waste Transport" has been requested, the length of time that the biota have had contact with the waste (assumed to start at the time of loss of institutional control) can be entered.

Line 60+M: The length of time prior to the time "Intake Begins" that the inventory "Disposal" was initiated (refer to Figure 3.1), BEFORE, yr.

Line 61+M: The length of time prior to the time that "Intake Begins" that Loss of Institutional Control (LOIC) occurred, allowing biotic transport to begin, LOIC, yr.

Line 62+M: A two-compartment model of plant roots is allowed: vegetation uptake is assumed to be proportional to the fraction of roots contacting 1) the mixed surface soil layer and 2) the layer of contaminated buried soil. (These two layers can be separated by a third, clean layer.) These root fractions are used in the regular plant concentration model, the harvest removal model, and the plant portion of the biotic transport model. The upper soil fraction is entered on this line, RF1.

Line 63+M: The deep soil root fraction is entered on this line, RF2.

Line 64+M: For scenarios involving physical disruption that mixes deeply buried waste (in ci/m^3) with surface soil (in Ci/m^2), a "Manual Redistribution" factor is available, MANULR. (A handy factor to remember is that throughout GENII, 1 Ci/m^3 = 0.15 Ci/m^2.)

Line 65+M: A simple geometric model of dose rate reduction for small surface areas is provided. Enter the area of the contaminated surface on this line in square meters, FRSIZ.

Lines 66+M to 67+M: Transport editing header.

Line 68+M, Column 1: Blank field.

Line 69+M, Column 1: A number of options are available to determine air concentrations from releases. These may be based on several levels of knowledge. The user may either input a chi/Q value or request that one be calculated. When a chi/q value is input, no decay correction is made by GENII. The user should calculate a decay correction for each radionuclide (if transit time is known) and the input release term reduced accordingly.

In the chronic individual calculation, three options of increasing complexity are available to determine the annual average atmospheric dispersion values:

- The simplest for GENII is to directly input a precalculated chi/Q, in sec/m^3. XOQOPT = 1.
- The next in complexity is when the user specifies the location of the individual, in terms of distance and direction from the source, and asks GENII to compute the chi/Q for that location. This option

requires that the user also have available one of two data sets: either a grid of precalculated chi/Q values or a set of joint frequency data for the source location. (See Section 2.3 for the format of these external data files.) If you choose to use the joint frequency data option, you must also enter data on the characteristics of the source, including whether or not release is elevated or ground level, and whether or not plume rise is calculated. XOQOPT = 3.

- Finally, if either a chi/Q grid or joint frequency file is available, you may instead direct GENII to search and find (select) the location of the maximally exposed individual via the air pathway. These options require data as described above for the specific individual, plus they require a population grid so that GENII does not assume an individual location where nobody lives. XOQOPT = 2.

In the chronic population calculation, three options of increasing complexity are available to determine the annual average atmospheric dispersion values.

The simplest for GENII is to directly input a precalculated population-weighted chi/Q value, in person-sec/m^3. XOQOPT = 1.

The next in complexity is where the user provides both a grid of precalculated chi/Q values and a matching grid of population, and allows GENII to cross-multiply the two to create a population-weighted chi/Q. XOQOPT = 0.

The third option requires the user to supply a joint frequency distribution in place of the chi/Q grid, and to allow the code to create the chi/Q grid. (See Section 2.3 for the format of the chi/Q and joint frequency files.) If you choose to use the joint frequency input option, you must also enter data on the characteristics of the source, including whether or not release is elevated or ground level and whether or not plume rise is calculated. XOQOPT = 0.

Note that you cannot request the "FINITE PLUME" submersion model without using one of the joint frequency options.

To determine the time-integrated air concentration for the acute individual exposure, two options are available.

The first is through input of a precalculated E/Q, in sec/m^3. XOQOPT = 1.

The second is to specify the distance and direction of the individual from the release point. This option requires that the user provide either a grid of precalculated E/Q values or a set of joint frequency data for the source location. (See Section 2.3 for the format of these external files.) If you choose to use the joint frequency option, the code will calculate the E/Q which is not exceeded more than 5% of the time for the specified location (i.e., the 95th percentile E/Q). For this option you must enter data on the source characteristics (including whether or not it is an elevated or ground-level release, whether or not to use the plume rise model, or whether or not to use the building wake model). XOQOPT = 3.

Note that you cannot request the "FINITE PLUME" submersion model without using one of the joint frequency options.

Two options are available for determining the population-weighted, time-integrated air concentration for acute population exposures.

The simplest is through user input of a precalculated population-weighted E/Q, in person-sec/m^3. XOQOPT = 1.

The second option is to specify the direction from the source for which the calculation is desired. This option requires that the user provide either a grid of precalculated E/Q values or a set of joint frequency data for the source location (see Section 2.3 for the format of these external files), and in addition a population grid file. If you choose the joint frequency option, the code will calculate the population-weighted E/Q which is not exceeded more than 5% of the time for the specified direction (i.e., the 95th percentile population-weighted E/Q). For this option you must enter data on the source characteristics (including whether or not it is an elevated or ground-level release, whether or not to use the plume rise model, and whether or not to consider the building wake model). XOQOPT = 3.

Note that you cannot request the "FINITE PLUME" submersion model without using one of the joint frequency options.

Line 70+M to 71+M, Column 1: Blank Fields.

Line 72+M, Column 1: Input chi/Q or population-weighted chi/Q, if used, goes on this line, XOQI, sec/m^3 or person-sec/m^3.

Line 73+M, Column 1: Sector index for the location of the Maximum Individual, MIDIR. The sector indices are:

1-S	5-W	9-N	13-E
2-SSW	6-WNW	10-NNE	14-ESE
3-SW	7-NW	11-NE	15-SE
4-WSW	8-NNW	12-ENE	16-SSE

Line 74+M, Column 1: Distance of Maximum Individual from the release point, meters, MIDIST.

Line 75+M, Column 1: Flag for use of joint frequency data, as defined by XOQOPT, JFIN.

Line 68+M, Column 2: Identifier for type of atmospheric release, IRELES.
The key is:
- 0 - Ground-level, open area
- 1 - Elevated stack greater than 2.5 times the height of the nearest building
- 2 - Elevated building vent
- 3 - Building vent below roof level

Line 69+M, Column 2: Flag for use of effective stack height (rather than calculate plume rise, STACK.

Line 70+M, Column 2: Stack height or effective stack height, SHITE, m.

Line 71+M, Column 2: Stack flow rate (for plume rise), SFLOW, m3/s.

Line 72+M, Column 2: Stack radius (for plume rise), SRAD, m.

Line 73+M, Column 2: Effluent temperature (for plume rise), ETEMP, degree C.

Line 74+M, Column 2: Building cross-sectional area (for building wake model), BUILDX, m^2.

Line 75+M, Column 2: Building height (for building wake model), BUILDH, m.

Line 76+M to 77+M: Surface Water Transport editing header. Three options are available to determine the surface water concentrations from chronic releases - a simple dilution volume model and more complex models of river and lake dispersion. The dilution volume model requires only input of the annual average flow of the receiving water body (i.e., river) and allows adjustment by a multiplicative input mixing ratio. The river and lake models generate mixing ratios and, from them, water concentrations as functions of flow velocity, water depth, effluent discharge rate, longshore and offshore distance, and other parameters.

Because of the nature of the acute model for surface water transport, only one model is available to determine time-integrated water concentrations. Required input is the average flow of the receiving water body and a multiplicative mixing ratio (usually 1.0 unless otherwise known). The entire source is assumed to be carried off by the river/lake flow.

Line 78+M: Indicator for which mixing ratio model to use. MIXFLG. Key is:

- 0 - Use input value on next line
- 1 - Calculate using the river model
- 2 - Calculate using the lake model

Line 79+M: Input mixing ratio for MIXFLG = 0, MIXR.

Line 80+M: Average river flow rate, SWFLOW. For MIXFLG = 0, the units are m^3/s; for MIXFLG = 1 or 2, the units are m/s.

Line 81+M: Transit time to irrigation withdrawal location, SWTT, h.

Line 82+M: Blank field.

Line 83+M: Rate of effluent discharge to receiving lake or river, SWQB, m^3/s.

Line 84+M: Longshore (downstream) distance from release point to withdrawal location, SWLSX, m.

Line 85+M: Offshore distance from the release point to the inlet location, SWOSY, m.

Line 86+M: Average water depth of receiving lake or river, SWDPTH, m.

Line 87+M: Average river width (for MIXFLG = 1 only), SWIDTH, m.

Line 88+M: Depth of effluent discharge point (in lake model only), SWDZ, m.

Lines 89+M to 90+M: Waste Form Availability editing header.

Line 91+M: Waste form or waste package half-life. "Buried Waste" acts as an additional soil compartment that feeds "Deep Soil" at a rate determined by the waste decomposition half-life. PACKHL, yr.

Line 92+M: Waste thickness. For near-field scenarios involving either "Buried Waste" or "Deep Soil", an estimate of the thickness of the contaminated zone is required for the harvest removal model. WASDEP, m.

Line 93+M: Depth of soil overburden. The depth to the top of this zone is required by the animal portion of the model of soil the animals might move. OVRBRD, m.

Lines 94+M to 95+M: Biotic Transport editing header.

Line 96+M: Flag for activating biotic transport during the period before exposure (refer to Figure 3.1). BTPRE.

Line 97+M: Flag for activating biotic transport during the intake period (refer to Figure 3.1). BTNTK.

Line 98+M: Index for the site conditions before the assumed exposure, BTDSET. Biotic transport may result in radionuclides reaching surface soil from "Buried Waste" or "Deep Soil" both during the period following waste disposal and loss of institutional control but before the initial time of human exposure via this scenario (the "Years since LOIC"). Biotic transport may also continue during the exposure period. Three possibilities are provided for the conditions existing at the site before the start of this scenario's exposure: arid non-agricultural uses, humid non-agricultural uses, or agricultural uses. The parameters that describe these conditions are simplifications of those used in McKenzie et al. (1982 and 1983).

Line 99+M to 104+M: Exposure editing header. The "EXTERNAL EXPOSURE" parameters help define the time during which the individuals or populations are exposed to sources of direct radiation from contaminated air, soil, water, or sediments. GENII uses fairly simple exposure geometries - shielding corrections for buildings, etc. are not included. If desired, simple reductions for shielding may be incorporated by reducing the time assumed for exposure.

For exposure to an acute air concentration, the fraction of time during plume passage that the person(s) is exposed is input. For exposures to soil and sediment following acute deposition, the exposure is modeled as chronic to a decaying source. Note that, if swimming and boating have been selected, certain assumptions have been "hard-wired" into the code for the acute case (100% exposure for maximum individual, 0% exposure for populations); so no inputs are requested.

Line 105+M, Column 1: Length of external exposure per year to chronic atmospheric plumes, HRPLUM, h.

Line 106+M, Column 1: Length of external exposure per year to soil contamination, HRGRD, h.

Line 107+M, Column 1: Length of time spent per year swimming in contaminated water, HRSWIM, h.

Line 108+M, Column 1: Length of time spent by individuals per year boating, HRBOAT, h.

Line 109+M, Column 1: Length of time spent by individuals exposed in shoreline activities, HRSHOR, h.

Line 105+M, Column 2: Flag for activating irrigation of residential soils (to model external exposure to irrigated soil), RESIRR.

Line 106+M, Column 2: Index for source of residential irrigation water, IRRSR, key is 1 - ground water, 2 - surface water.

Line 108+M, Column 2: The application rate of residential irrigation water, RIRR, inches/year.

Line 109+M, Column 2: Application period of residential irrigation, IRTIMR, Months/year.

Line 110+M: Index for type of shoreline at the exposure location, SHRTYP.

Key is : 1 - River shore
2 - Lake shore
3 - Ocean beaches
4 - Tidal basin

Line 111+M: Travel time of water from the release point to the recreational exposure point, RECTT, h.

Line 112+M: For the acute air submersion model, the fraction of total plume travel time that the individual spends in the plume, FRCLOD.

Line 113+M to 114+M: Inhalation editing header. GENII considers two sources for inhalation exposure: plumes from acute or chronic sources and resuspension from soil contamination. Exposure to plumes may be characterized by the time spent at a location within the plume, in hours/year for chronic exposure or fraction of plume passage time for acute releases, as defined in lines 103+m and 110+m above. Two models describing resuspension are available if desired. The Mass Loading model relates the local air concentration to the local soil concentration by assuming that dust in the air has the same concentrations as the soil. The Anspaugh model (Anspaugh 1975) is a time-dependent function relating surface activity to air concentration. GENII uses a fraction of the upper soil compartment to represent the surface activity.

Line 115+M: Hours per year an individual spends exposed to contaminated air from either chronic plumes or from resuspension. HRINH, h.

Line 116+M: Flag for activating resuspension models, IRES. Key is:

0 - No resuspension
1 - Use mass loading model
2 - Use Anspaugh (1975) model

Line 117+M: If IRES = 1, the mass loading factor XMLF, g/m^3. If IRES = 2, the depth of the top layer of soil that is available for resuspension AVALSL, cm.

Line 118+M to 119+M: Ingestion Population editing header. A common assumption in the older Hanford environmental codes was that food crops are produced and eaten where the people live. While not a bad assumption for individuals, this can lead to inaccuracies when the people live on one side of a source and the crops are grown on the other, or when not enough food is grown to support the entire population. GENII allows several options, of increasing complexity, to deal with food production.

The user may input a precalculated normalized food-production-weighted chi/Q value (option 0), analogous to a population-weighted chi/Q.

You may select to use the same distribution as used for the population, essentially assuming that the field and people are co-located (option 1).

If you know how much food is produced but not necessarily where, you may assume the crops are grown uniformly throughout the 80-km grid (option 2).

Finally, if you know the actual food production distribution, prepared as a file of values in kg/yr for each of the 10 x 16 grid points for each food type, this may be used with the chi/Q grid input or calculated for the population (option 3).

Note that with options 2 and 3, the potential for doses to people outside the region resulting from crop export may be considered, if desired.

Note: Only the option assuming co-location of crops and population (option 1) is currently available for acute releases. Model development for the other options is as yet incomplete.

Line 120+M: Option selection for food production, FOQOPT.

LINE 121+M: If FOQOPT = 0, then the food-weighted chi/Q is entered on this line, FOQ, kg-sec/m^3.

Line 122+M to 124+M: Editing information.

Line 125+M: The number of people ingesting the aquatic food harvest, AQUPOP, persons, if different than the total population. If a zero is entered on this line, the total population is assumed to eat aquatic foods. If you know the total consumption values (for instance, 100,000 kg of vegetables) and don't really care about how many people it feeds, put in a population of 1 and enter the other values later when required.

Line 126+M: The number of people drinking water from the contaminated source, DWPOP, persons, if different than the total population. If a zero is entered on this line, the total population is assumed to drink from the source.

Line 127+M: An option is available to consider the total production of foods in the assessment area. If not enough food is grown to support the population at the level of consumption indicated, a correction is made. Also, if more food is grown than can be consumed, an effective population can be developed to consider export from the region. The flag for this option is on this line, EXPORT.

Line 128+M to 132+M: Aquatic Food/Drinking Water editing header.

Line 133+M: Flag for consideration of freshwater or marine bioaccumulation factors for the aquatic food pathways, ISALT.

Line 134+M to 138+M: Aquatic Food/Drinking water editing header.

Line 139+M to 142+M, Columns 1 to 5: For each of the aquatic food types you select with the flag in the first column (AQF), several parameters must be entered. These include travel time of the radionuclides in the water to the point where the fish/etc. are caught (AQUTT), h, and the time between harvest and consumption (HLDUP2), day. These allow for proper accounting of decay for short-lived nuclides. Individual aquatic food consumption rates are also input here (USAG), kg/yr. In addition, if the export flag is on, the total production of aquatic food products may be entered (TPRODQ), kg/yr. Note that this is a formatted read, so the values entered must line up in the fields defined by the editing header.

Line 139+M to 142+M, Column 6: Because GENII allows simultaneous consideration of several sources of contamination (surface water and ground water), you need to indicate which source is to be used for drinking on Line 139+M, DWSRC. The key for the sources is:

- 0 - None
- 1 - Ground water
- 2 - Surface water
- 3 - Derived concentration from lines 42+N to 42+M

You will also need to indicate on Line 140+M whether the drinking water is treated through a water treatment facility (DWTRET). If so, reductions in concentration for filtration/cleanup will be calculated. The travel time of the water through the distribution system is also input on Line 141+M , HOLDDW, days, to allow calculation of decay of short-lived nuclides. Consumption of drinking water, (DWUSAG, L/yr), is input on Line 142+M.

Line 143+M to 149+M: Terrestrial Food editing header.

Line 150+M to 153+M: Input of terrestrial food parameters. For each of the terrestrial food types you select (flag TFD), several parameters must be entered. These help define the conditions under which the crops are grown, such as the length of the growing season (GRWP, days), the conditions of irrigation (source flag IRRST: irrigation rate RIRR, inches/year; irrigation period IRTIMT, months/year), and the yield of the crop (YELD, kg/m^2) as well as the total production, if required (TPRODT, kg/year). Individual food holdup times between harvest and storage (HLDUP, days) and consumption rates (CONS, kg/year) are also input here. Note that this is a formatted read, all input parameters must conform to the fields defined by the editing headers.

Note: Growing time is only used for the years after the release in acute cases. If you are only looking at dose commitment from the first year of exposure, whatever value you enter will be ignored.

Line 154+M to 161+M: Animal Product editing header.

Line 162+M to 165+M: For each of the animal products you may select (flag ANF), several parameters must be entered to define the conditions under which the products are produced. This includes not only the amount of each product consumed by humans (CONS2, kg/yr) and its holdup time (HLDUPA, days), but also the conditions for the foods that the animals themselves eat. The total production of each food type in the assessment area may be entered if required (TPRODA, kg/yr). The fraction of the drinking water that the animals consume (DWFACA) from contaminated sources is entered. Some animals are allowed two food sources (fresh forage and stored feed), so information on stored fraction (DIETFR), growing period (GRWPA, days), irrigation sources (IRRSA), rates (RIRRA, inches/year), times (IRTIMA, months/year), yields (YELDA, kg/m^2), and storage times (STORTM, days) must be provided for crops eaten by the animals. This information is entered on these lines for the stored feed. Note that these are formatted reads, and the information must fit in the fields defined by the editing headers.

Line 166+M: Fresh Forage editing header.

Line 167+M to 168+M: Some animals are allowed two food sources (fresh forage and stored feed), so information on diet fraction (DIETFR), growing period (GRWPA, days), irrigation sources (IRRSA), rates (RIRRA, inches/year), times (IRTIMA, months/year), yields (YELDA, kg/m^2), and storage times (STORTM, days) must be provided for the crops the animals eat. These are entered on these lines for the fresh forage eaten by beef and milk cattle. Note that these are formatted reads, and the information must fit in the fields defined by the editing headers.

Line 169+M to 170+M: File delineation header.

3.3 EXTDF

EXTDF is a streamlined and updated version of the radionuclide shielding code ISOSHLD (Engle 1966). The input to the code is supplied through an ASCII text file designated EXTDF.IN. This section describes the format for the EXTDF input file. The input is subdivided into three portions, following the original ISOSHLD convention: a title, NAMELIST, and shield specification.

3.3.1 Title

The initial input line is a Case Title, which is read and copied verbatim on the output of the code. Use this line as a unique identifier for the calculation being performed.

3.3.2 NAMELIST

The second input grouping is the NAMELIST input. NAMELIST is a useful FORTRAN specification allowing selective input of variables. NAMELIST variables have default values (i.e., the program assigns a value to the variable if the user does not specify a value in the input.) A principle advantage of the NAMELIST format is that values for which the defaults are acceptable, or which are not used in a particular calculation, need not be initialized. All of the NAMELIST variables that EXTDF accepts as input are defined below, along with their default values. The NAMELIST variables are grouped into four categories: source distribution, geometry, shielding, and integration.

In the NAMELIST the variable name is written out, followed by an equal sign and the numeric value assigned to that variable. NAMELISTs begin and end with the character "&" and in EXTDF are identified by the word "INPUT" immediately following the first "&". The last "&" must be preceded by a blank space. All lines in a NAMELIST field must begin with a blank space. NAMELIST entries are separated by commas. Array values may be input independently of the value of other array entries, as long as the variable name includes the array position.

A NAMELIST parameter, IEXTU, has been added for specifying input/output units. A unit input of 1.0 is automatically defined for each radionuclide. The following values of IEXTU and their corresponding units are as follows:

0	- rem/h per Ci/cm3	(ISOSHLD default)
1	- mrem/h per Ci/m3	(MAXI1)
2	- mrem/yr per μCi/cm3	(Kocher)
3	- person Sv/yr per Bq/m3	(GENII air)
4	- person Sv/yr per Bq/L	(GENII on water surface)
5	- mrem/yr per μCi/cm2	(Kocher)
6	- person Sv/yr per Bq/m2	(GENII ground)
7	- mrem/yr per pCi/m3	(IMPACTS-BRC ground)

Source Distribution

EXTDF is intended for generating normalized tables of external dose rate factors for various geometries. Therefore, the sources are generally assumed to be unit sources. However, a common input multiplier, WIN, is available. This multiplier can be used to increase or decrease every input radionuclide inventory by a specific amount. The default value is 1.0, a normalized input strength. The radioactive source need not be uniformly distributed within the source material. The variable SSV1 can be used to create an exponential source strength distribution. Legal values are between -10 and +10. If no value is specified, the program uses zero; i.e., a uniform source distribution. Details on the geometries that allow the use of the SSV1 parameter are given below.

Shielding

The variable NSHLD tells the program how many shields will be used in this problem. A maximum of five is permitted. The program automatically inserts a layer of air as the last shield before the detector (dose point) if the entire distance is not specified as containing shields.

The variable JBUF tells the program which material should be used in computing the build-up factor. If no value is entered, JBUF is automatically set to NSHLD. The common shielding convention is to assign JBUF to the outermost shield (i.e. that closest to the detector) that has at least one relaxation length of material for the energy groups giving the majority of the dose rate. A relaxation length is the inverse of the linear attenuation coefficient. If the outermost shield is not thick enough, then the thickest shield (in terms of relaxation lengths) should be chosen for the build-up factor.

Geometry

The IGEOM variable sets the geometrical shape of the source and shields. Table 3.1 provides the available options.

For each geometry, additional NAMELIST variables specify the dimensions of the source and the distance from the source to the detector. These variables are X, the total distance from the back of the source to the detector; T, the thickness of each of the shield regions; SLTH, the length of the source; Y, the vertical distance from the end of the source to the detector; ANG1, the shield normal angle; and ANG2, the detector angle. All dimensions are in centimeters, all angles are in degrees. Not all of the variables are required for each geometry selection. Definition of these parameters for each geometry is illustrated in the geometry diagrams, Figures 3.2 through 3.12. These diagrams are taken directly from the original ISOSHLD documentation (Engle 1966; Simmonds 1967).

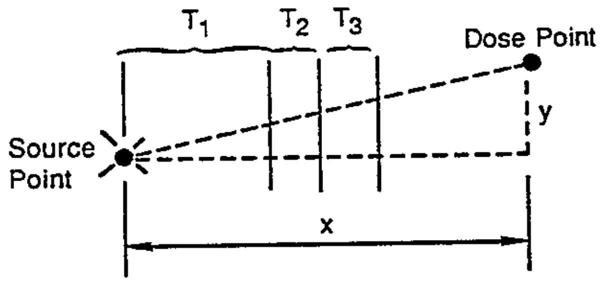
TABLE 3.1. IGEOM Values and Their Relationships to Sources and Shields

IGEOM Value	Source Configuration	Shield Configuration
1	Point	Slab
2	Line	Slab
3	Spherical	Spherical
4	Spherical	Slab
5	Truncated Cone	Slab
5	Infinite Plane	Slab
5	Infinite Slab	Slab
6	Disc	Slab
7	Cylindrical (side)	Cylindrical
8	Cylindrical (side)	Slab
9	Cylindrical (side)	Cylindrical and Slab
10	Cylindrical (end)	Slab
11	Rectangular	Slab
12	Annular Cylinder	Cylindrical and Slab

Integration Variables

The EXTDF solution technique includes a point kernel integration, in which the source is represented as a series of point sources in space and the contribution from each point is calculated and summed to a total dose rate. The number and orientation of the point sources are determined by the integration variables selected by the user. These are NTHETA, NPSI, and DELR. The variables NTHETA and NPSI determine how many intervals the source is divided into. The variable DELR is the thickness of the pieces, in centimeters. Not all of the geometries require specification of these parameters. They are required only for geometries 7 through 12.

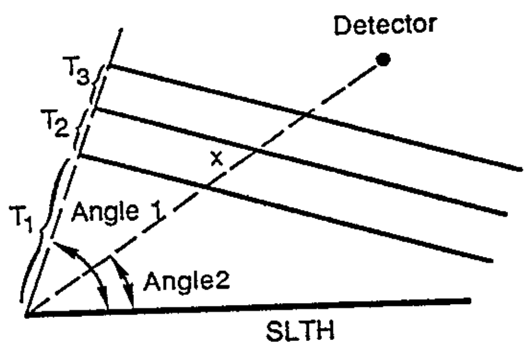
The optimal choices for these variables depend on the distance from the source and the geometry. Typically, the best choices are values of NTHETA and NPSI that give volumes that are not much larger than the distance from the face of the source. DELR should be no more than one relaxation length in the source material. When the detector is close to the source, DELR should be less than one-half of a relaxation length.



INPUT VARIABLES

T_1, T_2, T_3 = shield thicknesses
IGEOM = 1
X = Perpendicular distance to detector
Y = Parallel distance to detector

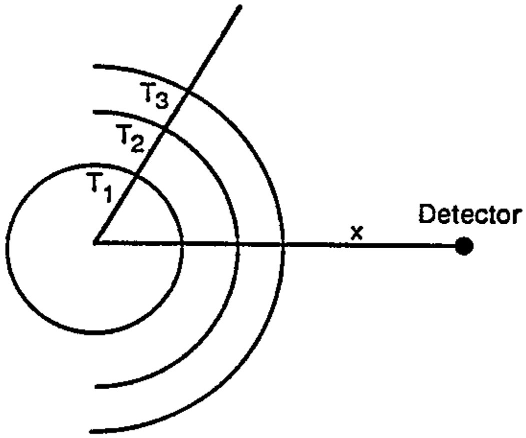
FIGURE 3.2. Point Source - Slab Shields



INPUT VARIABLES

IGEOM = 2
X = Distance to detector
Angle 1 = Shield normal angle
Angle 2 = Detector angle
SLTH = Source length
T_1, T_2, T_3 = Shield thicknesses

FIGURE 3.3. Line Source - Slab Shields

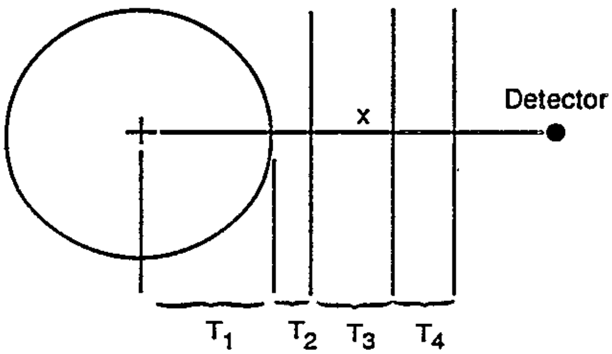


INPUT VARIABLES

IGEOM = 3
X = Distance from center to detector
T_1 = Source radius
T_2, T_3 = Shield radii

Note: Constant source strength distribution only for spherical source

FIGURE 3.4. Spherical Source and Shields

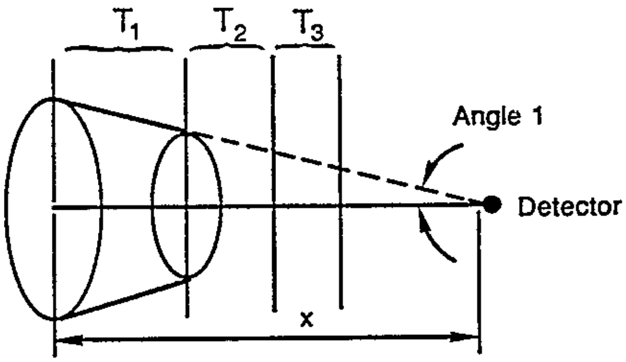


INPUT VARIABLES

IGEOM = 4
X = Distance from center to detector
T_1 = Source radius
T_2, T_3, etc. = shield thicknesses

Note: Constant source strength distribution only for spherical source. Shield region 2 surrounds the source.

FIGURE 3.5. Spherical Source - Slab Shields



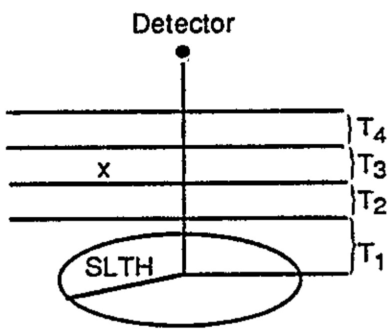
INPUT VARIABLES

```
    IGEOM = 5
  Angle 1 = Cone angle
     T(1) = Source thickness
        X = Distance to detector
            from opposite face
```

Notes: If Angle 1 = 90.0° (infinite slab source), then the source strength is input in activity per unit volume.

If T(1) = 0 and Angle 1 = 90.0° (infinite plane source), then the source is input in activity per unit area.

FIGURE 3.6. Truncated Cone Source - Slab Shields

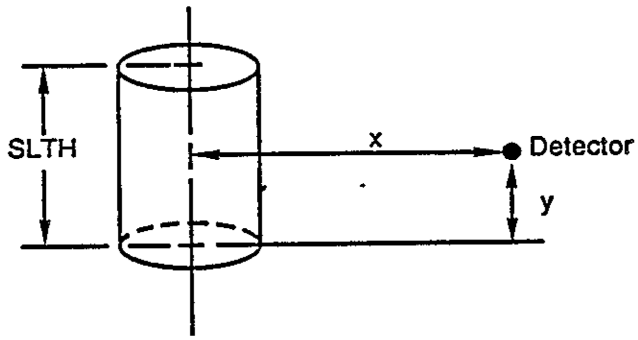


INPUT VARIABLES

```
IGEOM = 6
 SLTH - Disk radius
    X = Distance from center to
        detector
```

Note: Source strength input is in activity per unit area.

FIGURE 3.7. Disk Source - Detector on Centerline - Slab Shields

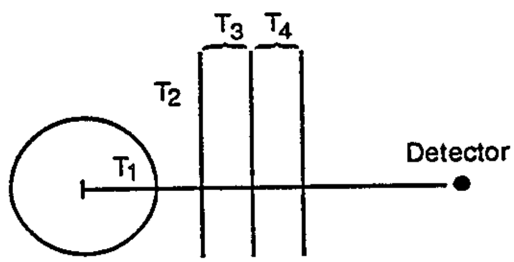


INPUT VARIABLE

IGEOM = 7 for cylindrical shields
IGEOM = 8 for slab shields
SLTH = Length of source
X = Radial distance to detector from centerline of source
Y = Vertical distance from end of source to detector

a. Cylindrical Source, Isometric View.

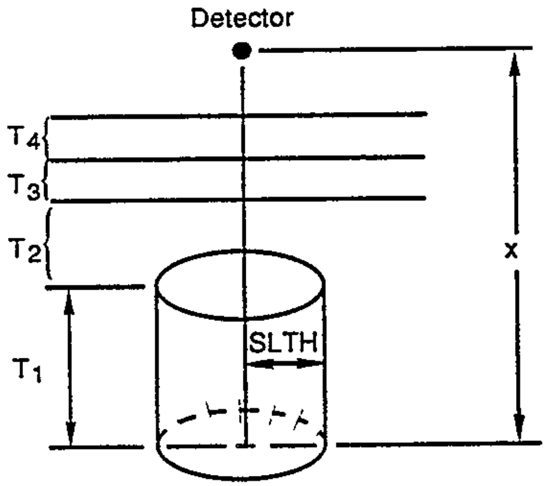
Note: Y may not be greater than SLTH. (When a value of Y greater than SLTH is entered, the program arbitrarily sets Y = 0.)



b. Cylindrical Source, End View.

Note: With slab shield, the second shield region surrounds the source.

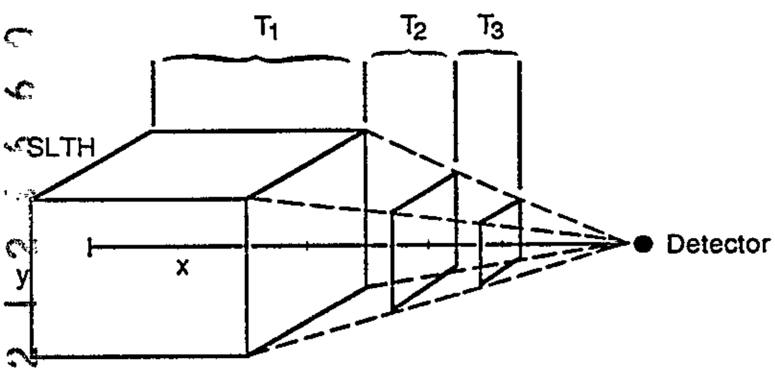
FIGURE 3.8. Cylindrical Source - Cylindrical and Slab Shields



INPUT VARIABLES

IGEOM = 9
SLTH = Radius
T_1 = Cylinder length
X = Distance to detector from opposite end
T_2, T_3, T_4 = Shield thicknesses

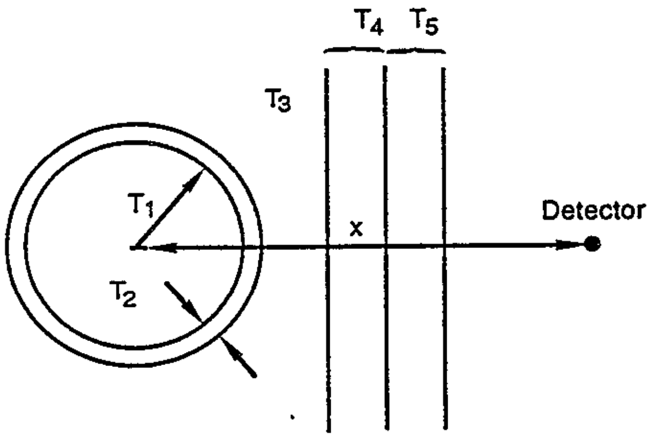
FIGURE 3.9. End Cylindrical Source - Detector on Centerline - Slab Shields



INPUT VARIABLES

IGEOM = 10
X = Distance to detector from opposite fact of source
Y = Height of source
SLTH = Length of source
T_1 = Thickness of source
T_2, T_3 = Shield thicknesses

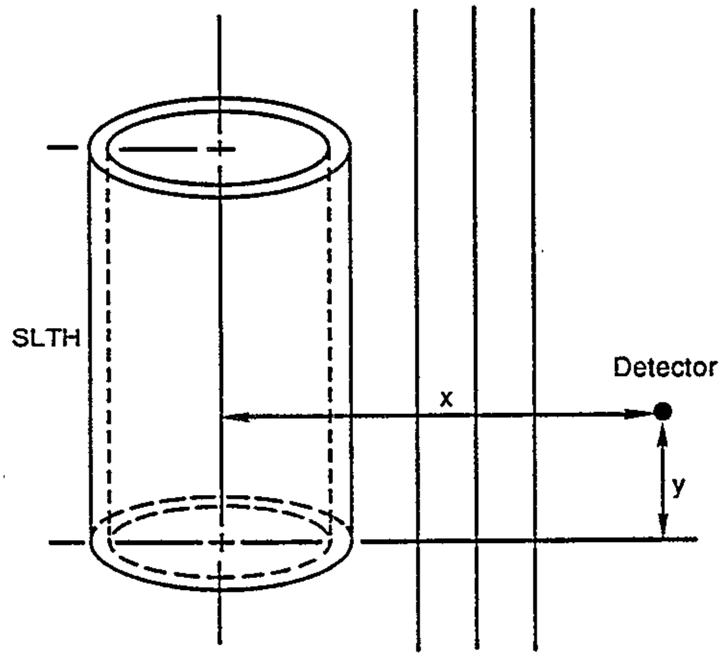
FIGURE 3.10. Rectangular Source - Detector on Centerline - Slab Shields



INPUT VARIABLES

IGEOM = 11
SLTH = Length of source
X = Radial distance to detector from centerline of source
Y = Vertical distance from end of source to detector
T_1 = Radius of source
T_2 = Wall thickness of container
T_3 = Distance from container outer wall to first slab shield

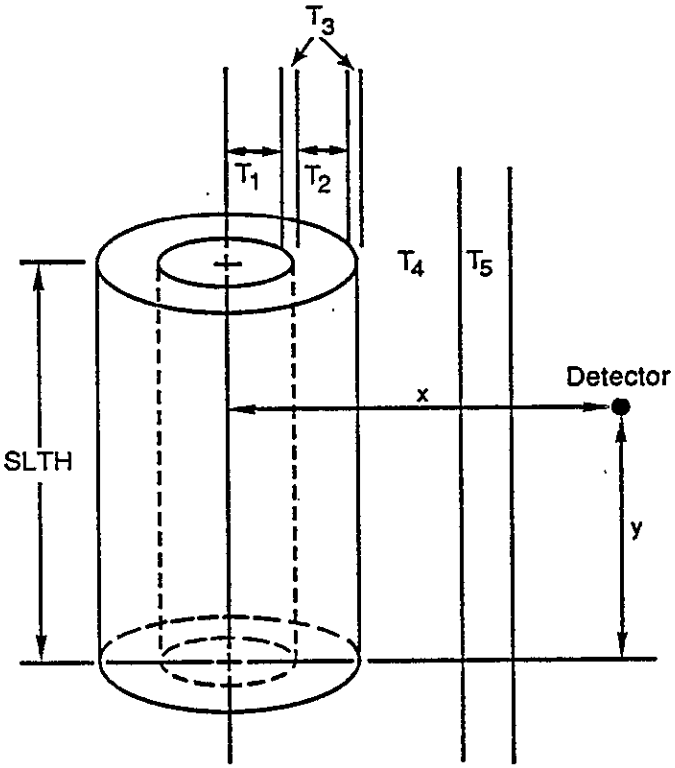
a. Plan View



b. Isometric View

Note: Second shield, T(2), is cylindrical. The third shield, T(3), has slab face but surrounds the first and second shields. The remaining shields are slabs. (When a value of Y greater than SLTH is entered, the program arbitrarily sets y = 0.)

FIGURE 3.11. Cylindrical Source - Cylindrical and Slab Shields



INPUT VARIABLES

IGEOM = 12
T_1 = Inner radius of the annulus
T_2 = Annulus width (source)
T_3 = Container wall thickness
SLTH = Length of source
X = Radial distance to detector from centerline of source
Y = Vertical distance from end of source to detector
T_4, T_5 = Shield thicknesses

Notes: Y may not be greater than SLTH. (When a value of Y greater than SLTH is entered, the program arbitrarily sets Y = 0.)

T_3 is the thickness of the inner and outer walls of the container, which must be equal.

FIGURE 3.12. Annular Cylindrical Source - Cylindrical and Slab Shields

3.3.3 Shield Material Specification

Following the NAMELIST comes the shield specification block. There may be up to five shields, and each shield may be composed of a single material or a mixture of an unlimited number of materials (up to all 20 available materials). For alloys or homogeneous mixtures of materials, the density of each material as it is found in that shield is used. Data is read in an unformatted format; each line specifies the density, in grams/cm^3, of one material for each of the five shields. Each line must contain a continuation key, the material identification number, and the density of that material in each of the shields. The continuation key is an integer, either zero if there are additional materials to be considered, or a one if this is the last material. The material identification number corresponds to the definitions given in Table 3.2. Note that because the read is free format, zero values must be entered. Thus, one key, one identification number, and five densities will always be on each line.

3.4 INTDF

The INTDF code produces radiation dose factors using the techniques of ICRP 30 (1979a, 1979b, 1980, 1981a, 1981b, 1982a, 1982b). A single run will generate both ingestion and inhalation dose factors. The dose factors are prepared as both dose commitments, by organ for the uptake and integration periods desired, and as annual dose increments. Output from the calculation is summarized on the standard output file INTDF.OUT, the dose commitments are stored in file CDE.OUT, and the dose increments are stored in file CDEINC.OUT. Manipulation of these output files allows the creation of the dose factor files used by the DITTY and DOSE routines.

Input to INTDF is brief. The first line is reserved for a title, which is reproduced on each page of output and in the data summary files. On the following four lines the user indicates:

- the number of years to consider
- whether or not (True/False) the exposure is acute or chronic (i.e., whether the dose factors are being created for the DOSE or DITTY routine)

TABLE 3.2. Shield Material Specifications Available in EXTDF

Identification Number	Material	Usual Specific Gravity	Effective Atomic Number	Effective Atomic Number
1	Water	1.0	4	6
2	Tissue	1.0	4	6
3	Air	0.00129	7	14
4	Hydrogen	0.00008	1	1
5	Lithium	0.532	3	7
6	Carbon	2.0	6	12
7	Aluminum	2.702	13	27
8	Titanium	4.5	22	48
9	Iron	7.8	26	56
10	Nickel	8.90	28	59
11	Zirconium	6.44	40	91
12	Tin	7.3	50	119
13	Tungsten	19.3	74	184
14	Lead	11.35	82	207
15	Uranium	18.75	92	238
16	Ordinary Concrete	2.35	10	19
17	Magnetite Concrete	3.76	12	24
18	Strontium	2.6	38	88
19	Promethium		61	145
20	Cerium		96	245

- particle size in microns, to allow determination of lung deposition from inhalation
- whether or not (True/False) the specific effective energies should be printed in the output file (when set, additional output is printed to the screen during execution, which may be used in tracing the internal calculations).

The remaining lines of the input section consist primarily of instructions to the Livermore Solver for Ordinary Differential Equations (Stiff) which is embedded in the code (Hindmarsh 1983). It is generally not necessary for the user to modify these parameters for the INTDF application. The values provided in the sample problems have been developed through numerous tests, and have been shown to both result in accurate results and minimize computational time for all radionuclides in the GENII libraries. The LSODES parameters have been left in the input to facilitate research use of the INTDF module. The LSODES control parameters are:

- the relative error tolerance parameter, RTOL,
- the absolute error tolerance parameter, ATOL. RTOL and ATOL are used in the LSODES numerical iteration scheme to control the number of iterations required and maintain accuracy of the integrated result. The solver controls the vector E = E(I) of estimated local errors in the integrated retention vector Y according to an inequality of the form Root-Mean-Square Norm E(I)/EWT(I) < 1.0, where EWT(I) = RTOL * ABS(Y(I)) + ATOL. Values of 10^{-6} for RTOL and 10^{-8} for ATOL have been tested and found adequate.
- the maximum absolute time step size the solver is allowed to take, ASSA. Because annual dose increments are calculated, and the code operates on a time unit of days, this has been set to 365 days.
- the initial time step size that the solver should use, HSTART. A value of 10^{-6} days has been found to accommodate all short transients associated with the radionuclides of interest.
- the maximum number of iterations the solver is allowed to take to reach convergence on any one call, NSC. This prevents the machine from getting into infinite loops if there is an error. A value of 700 is recommended as adequate for the calculations of dose factors.

A final input line relates to a developmental capability planned for INTDF. The capability is not completely developed to calculate radiation dose to the thyroid of a developing fetus as a result of maternal radionuclide intake of iodine, and dose factors for fetal exposures are not included in the dose factor files routinely addressed by the DOSE or DITTY programs.

The fetal dose calculation capability should not be used in other than research applications with this version.

Following the input section, the user enters radionuclides to be considered, up to a maximum of 100. Nuclide names must match the spelling of those in RMDLIB. Be careful to enter a return after the last radionuclide, and do not include any blank lines in the file.

3.5 DITTY

Use of the computer program DITTY requires proper assignment of several data files and careful preparation of an input record file. This section describes preparation of the input record file. This file has been designed to allow efficient use of the computer program with minimum effort by the user in preparing input records. Each execution of DITTY can have an unlimited number of cases. An execution file for DITTY contains the following classes of records:

1. A master radionuclide control list defining any radionuclides considered in this set. Radionuclides considered in any of the cases in the set are based on the interrelationship of several parameters:
    - time of release in relation to time period considered
    - type of release (acute or chronic) and whether that type of release is considered in a particular problem of a set
    - release pathway (airborne or waterborne) and whether that pathway is considered in a particular problem of the set
    - input options for release data; whether release data is read for this case or whether release data is in effect from a previous problem.
2. A group of records for each problem in the set consisting of the following types of records:
    - title for this case (Note: the title for the first case of a set is positioned before the master radionuclide list.)
    - a NAMELIST parameter set
    - air concentration factors, optional

- joint frequency data, optional
- population distribution data (record types 8 and 9), optional
- activity airborne release data, optional
- activity waterborne release data, optional.

The order of the records is determined by control integers as indicated in the input record logic diagram of Figure 3.13. This diagram should be referred to when preparing input records for DITTY. Each record type is discussed in the following sections.

3.5.1 Case Structure Parameters

The first record for each run is a title for the first case as described in Table 3.3.

At the beginning of each run, names of all radionuclides to be considered are read. These names are used to select needed data from library files. The number of names is read followed by the names of the radionuclides. The data record formats are described in Table 3.4. The maximum number of radionuclides allowed is 100. This number includes any unsolicited daughters which will automatically be added to the master list by the program. Addition of daughters is determined by decay chain information in the radionuclide data library (see Section 2.3.1.).

The spelling of the radionuclide name symbols must correspond to the spelling given in the master radionuclide data library, Section 2.3.1.

3.5.2 NAMELIST INPUT Parameters

The data records for the master radionuclide list are read at the beginning of each run. The remaining records are read for each case as determined by input parameters. Control parameters and selected model parameters are read next in a NAMELIST INPUT record set. The first record of this set must begin with INPUT in columns 2-7, and the last record must end with END in any column except column 1. Each parameter is supplied by setting it equal to the desired value. For example, to set the parameter IPATH to 2, enter IPATH = 2 starting after column 8 on the first record. Array values are specified by including the array subscript. For example, to set position 2

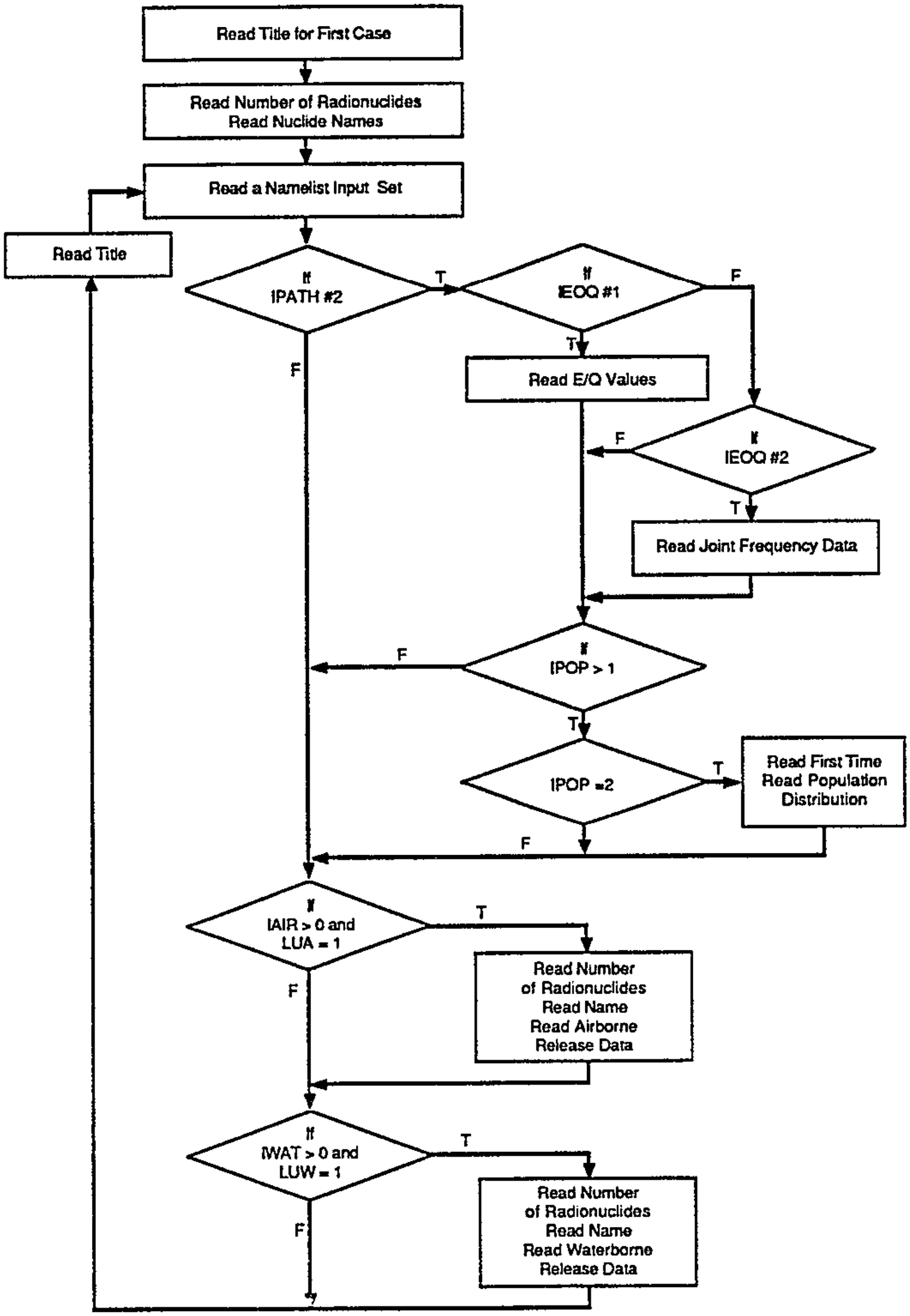


FIGURE 3.13. DITTY Input Logic Diagram

TABLE 3.3. Case Title Format

Variable	Columns	Format	Description
CASTTL(2)	1-80	20A4	Descriptive title for the current run to be printed on output report headings

TABLE 3.4. Master Radionuclide Name Format

Parameter	Columns	Format	Description
NIN	1-5	I5	Number of radionuclide names to be read, $1 \leq$ NIN ≤ 100 ($1 \leq$ NIN ≤ 25 for IBM-PC)
E(i)	1-2	A2	Element symbol for a radionuclide.
A(i)	3-8	A6	Atomic weight symbol for the radionuclide

of the array LORG to 6, enter LORG(2) = 6. Each entry must be separated by a comma. The NAMELIST INPUT parameters recognized by "DITTY" are described in Section 3.5.1 by the following categories:

- general control integers
- time references
- site grid description
- atmospheric dispersion
- population description
- waterborne pathways
- terrestrial pathways (for airborne and waterborne releases)
- graphical output selection options.

A. General Control Integers

IAC — To consider an acute release period at the beginning of the first 70-yr period, set IAC > 0. Default is IAC = 0.

IAIR — This parameter is set positive if airborne release activity data are to be read. Default is IAIR = 0.

IPATH — This parameter selects pathways to be considered as follows:

IPATH $\leq$ 0; airborne and waterborne
IPATH = 1; airborne only
IPATH $\geq$ 2; waterborne only

No default value is specified for IPATH.

IREDE — This parameter controls printing of detailed reports of dose by radionuclide and by pathway. If IREDE > 0, additional reports are printed.

IWAT — This parameter is set positive if waterborne release activity data are to be read. Default is IWAT = 0.

LUA — This parameter selects the input logical file unit for reading of airborne release activity data as follows:

LUA = 1; use input file
LUA ≠ 1; use data file buffer AIRREL.IN (see Section 2.2.11)

Default is LUA = 1.

LUW — This parameter selects the input logical file unit for reading of waterborne release activity data as follows:

LUW = 1; use input file
LUW ≠ 1; use data file buffer WATREL.IN (see Section 2.2.10)

Default is LUW = 1.

ISALT — This parameter determines if fresh or saltwater factors are considered in bioaccumulation factors as follows:

ISALT = 0; freshwater
ISALT = 1; saltwater

Default is ISALT = 0

B. Time Reference Parameters

TZ — The beginning of the ten-thousand-year dose period is given by this parameter in years A.D. Default is TZ = 2000.

TZR — The beginning of the release history data is given by this parameter in years A.D. TZR is used for both airborne and waterborne release data. Default is TZR = 2000. For acute exposure case, TZR must be equal to TZ.

C. Site Grid Description Parameters

DIST(10) — These values represent the distance from the release point to the midpoint of each distance interval, meters. Default values are not specified for DIST.

NDIST This integer gives the number of distance intervals to be considered, 1 ≤ NDIST ≤ 10. Default is NDIST = Ø.

NSECT This integer gives the number of sectors to be considered in the calculation of population dispersion factors (PM) and in the atmospheric dispersion calculation. 1 ≤ NSECT ≤ 16. Default is NSECT = 16.

D. Atmospheric Dispersion Parameters

IEOQ This integer is used to control reading and calculation of atmospheric dispersion data as follows:

IEOQ ≤ 0; use previous data

IEOQ = 1; read normalized air concentrations from data file buffer CHIQ.IN (see Section 2.2.3)

IEOQ = 2; read joint frequency data from data file buffer JOINTFRE.IN (see Section 2.2.2) and calculate normalized air concentration

IEOQ = 3; use previous data to calculate normalized air concentration

IEOQ 3; use previous data.

Default is IEOQ = 0.

HS This parameter gives the effective release height for airborne release. HS is used when normalized air concentrations are to be calculated (IEOQ = 2 or 3). Default is HS = 0.

E. Population Description Parameters

Population Parameters for Chronic Airborne Releases

Population dispersion factors are required for each 70-yr increment of the 10,000 year integration period (143 increments). Six options are provided for generation of the population dispersion factors for chronic airborne releases.

Method One. The first method allows the user to supply all values through input (IPOP = 1).

Method Two. The second method (IPOP = 2) uses an initial population distribution to generate the population dispersion factor for the first time increment. Then the increase in total population is supplied as a function of time and the program increases the population dispersion factor in proportion to the population increase.

The user supplies the initial distribution in the file buffer POP.IN (see Section 2.2.4).

<u>Method Three</u>. The third method (IPOP = 3) uses population distributions at specified times read from file buffer POP.IN (see Section 2.2.4). Population dispersion values are calculated for each specified time. These values are interpolated to determine the population dispersion values for each 70-yr increment.

<u>Method Four</u>. The fourth method (IPOP = 4) allows specification of population dispersion values at specified times. This data is interpolated to determine values for each 70-yr increment.

<u>Method Five</u>. The fifth method (IPOP = 5) uses the previous population distribution data but new $\bar{\chi}/Q'$data to generate the first time value for PM (air) or PL (water).

The second, third, and fifth methods use atmospheric dispersion data ($\bar{\chi}/Q'$ values) as calculated in subroutine EOVRQ or supplied on input.

<u>Method Six</u>. The sixth method (IPOP = 6) indicates that there is no chronic release. Use of this method ensures that population is specified properly for a case with an acute release only.

IPOP — This control integer selects the method for determining population dispersion factors for airborne releases as follows:

- IPOP $\leq$ 0; use previous value. No additional population input required.
- IPOP = 1; supply all 144 values for array PM in NAMELIST INPUT.
- IPOP = 2; read population data for the first time, T(1), and calculate PM. Then generate PM for other times from population (PM1) and time (T) data by ratio with initial total population. Supply NAMELIST INPUT parameters NTA, T, and PM1.
- IPOP = 3; read population data for each time from file buffer POP.IN and calculate PM for each time.
- IPOP = 4; supply population dispersion factors in array PM1 at times T, and interpolate this data to generate PM values for each 70-yr increment. Supply values for NAMELIST INPUT parameters NTA, T, and PM1.
- IPOP = 5; use previous population distribution data but recalculate the first time value for PM using new $\bar{\chi}/Q'$data. This method is similar to method 2 except no population data is read. No additional population input required.

IPOP = 6; There will be no chronic release during this case (IPA must be used).

IPOP > 6; not allowed.

Default is IPOP = 4.

NTA — This integer gives the number of times for which airborne population history data are supplied in arrays PM1 and T. $1 \leq NTA \leq 20$. Default is 1.

PM(144) — Population dispersion factor, person-sec/m^3 for airborne releases for each 70-yr period. This is an effective population-weighted χ/Q'.

PM1(20) — This array gives population dispersion factor data for airborne releases corresponding to times in array T. This data is used when IPATH $\leq$ 1 and IPA > 1 or when IPOP = 2, 4, or 5. When IPOP = 2, the data represents total population at each time. When IPOP = 4, the data represents population dispersion factors. When IPOP = 5, previous data are used (the form is not important). When IPA > 1, the data represents population dispersion factors unless IPOP = 2, in which case total population values are given. Default values are not specified for PM1.

POPT(2) — This array gives total population for airborne releases at each time given in array T. POPT is used for IPATH $\leq$ 1 and IPOP = 2 or 5. Default is all POPT values set to zero.

T(20) — This array gives times at which population data is supplied for airborne releases. Times are in years A.D. T is used when IPATH $\leq$ 1 and IPOP = 2, 4, or 5 or IPA > 1.

Population Parameters for Acute Airborne Releases

IPA — This control integer indicates the method (see text for discussion of methods) for specifying the population dispersion factor for the acute release period for airborne releases.

IPA $\leq$ 0; use previous values
IPA = 1; use the value given for PMA
IPA = 2; calculate the value for time TZ from calculated time history data; population data for chronic airborne release must be entered if this option is selected.

Default is IPA = 1.

PMA — This parameter is the population dispersion factor for the acute airborne release period used when IAC > 0 and IPA = 1. Default value is PMA = 0.

Population Parameters for Chronic Waterborne Releases

IPOPL This control integer selects the method for determining populations for waterborne release as follows:

IPOPL $\leq$ 0; use previous PL values. No additional population input required.

IPOPL = 1; supply all 144 values for array PL in NAMELIST INPUT.

IPOPL = 2; supply total population value data in arrays PL1 and TL and generate PL values by interpolation. Provide values for NAMELIST INPUT parameters NTL, TL, and PL1.

IPOPL > 2; not allowed.

Default is IPOPL = 2.

NTL This integer gives the number of times for which waterborne population history data are supplied in arrays PL1 and TL. $1 \leq$ NTL ≤ 20. Default is 1.

PL(144) This array gives total population for waterborne pathways for the acute period, PL(1) and each 70-yr period (143). Default is all values set to zero.

PL1(20) This array gives total population for waterborne pathways corresponding to times in array TL. This data is used when IPL > 1 or when IPOPL = 2. Default is all PL1 values set to zero.

TL(20) This array gives time at which population data is supplied for waterborne releases. Times are in years A.D. TL is used when IPATH $\neq$ 1 and either IPL > 1 or IPOPL = 2. Default values for TL are zero.

Population Parameters for Acute Waterborne Releases

IPL This control integer indicates the method for specifying population data for the acute release period for waterborne releases.

IPL $\leq$ 0; use previous values. No additional population required.
IPL = 1; use the value given for PPL
IPL > 1; calculate the value for time TZ from given population time history data. Population data for chronic waterborne release must be entered if this option is set > 1.

PPL This parameter is the total population for the acute waterborne release period used when IAC > 0 and IPL = 1. Default value is PPL = 0.

F. Waterborne Pathway Parameters

CFLO — This parameter is used in calculating the dilution of liquid releases. It is the flow rate, in cubic feet per second (cfs), of the water into which the radionuclides are released. A default value is not specified for CFLO.

RECON — This parameter is also used in calculating liquid dilution. It is used in particular cases where the inlet to a contamination facility is downstream of the outlet where reconcentration may occur. Default is 1.0.

RM — This parameter is used in calculating liquid dilution where the receptor is near the release point. It relates the amount of the river flow actually mixed with the released radionuclides. $0 \leq RM \leq 1$. Default is 1.0.

USAGE(7) — This array contains input values of the consumption or exposure rates for the waterborne pathway parameters for individuals:

1. fish consumption, kg/yr
2. crustacea consumption, kg/yr
3. mollusk consumption, kg/yr
4. water plant consumption, kg/yr
5. drinking water consumption, L/yr
6. exposure to contaminated sediments, h/yr
7. swimming in contaminated water, h/yr.

G. Terrestrial Pathway Parameters

CONSUM(7) — This array contains values of consumption rates, kg/h, for the terrestrial pathways for individuals:

1. leafy vegetables
2. other vegetables
3. eggs
4. milk
5. beef
6. unused
7. poultry.

EXTIM — This parameter relates the average time, h/yr, that an individual spends exposed to surface soils contaminated by either atmospheric or irrigation deposition.

GWRP(7) — This growing period (time of foliage above ground) for the 7 crops enumerated under the variable CONSUM. For the animal products, GRWP is the time above ground for feed or forage.

MOPYR — This value is the months per year that irrigation is used on crops.

RIRR This parameter is the irrigation rate of the crops under CONSUM. The units in DITTY are L/m^2/month. For the animal products, this is the irrigation rate of the animal forage crops.

YELD(7) This array contains the crop or forage yield, kg/m^2, for the 7 pathways under CONSUM.

H. Graphical Output Control Parameters

Some QA input data and results from DITTY1 calculations are presented as graphical functions of the data versus time. Various parameters may be plotted as described below.

IGRPM This parameter allows plotting of the population weighted $\overline{\chi}/Q'$ (PM) versus time if initialized. Default is IGRPM = 0.

IGRPL This parameter allows plotting of the total population affected by aquatic pathways if nonzero. Default is IGRPL = 0.

IGRTNU This parameter allows plotting of the total radionuclide release rate, in curies per 70-yr period versus time, if nonzero. Default is IGRTNU = 0.

IGRNUC This parameter allows plotting of the release rates of individual radionuclides, curies per 70-yr period, versus time if nonzero. If IGRNUC is equal to zero, a numeric report of release activity is printed for each radionuclide. Default is IGRNUC = 0.

IGRDOS This parameter allows plotting of the dose to each organ versus time in the output if nonzero. Default: IGRDOS = Ø.

3.5.3 Other Input Parameters

The NAMELIST parameter IEOQ controls input of atmospheric dispersion data. When IEOQ = 1, normalized air concentration data (E/Q) are read from file buffer CHIQ.IN (see Section 2.2.3).

When IEOQ = 2, the normalized air concentration values are to be calculated from annual average meteorological data of joint frequency of occurrence of wind speed, atmospheric stability, and wind direction. This data is read from file buffer JOINTFRE.IN (see Section 2.2.2).

When the population control integer IPOP is equal to 2, one set of population distribution data is read from file buffer POP.IN (see Section 2.2.4).

Airborne release data may be included in the input stream (IAIR > and ILUA = 1). One set of records is read for each radionuclide. Reading is terminated by placing a zero value for parameter NT of the last record of the set. These records are described in Table 3.5.

When waterborne releases are to be included in the input stream (IWAT > 0 and LUW = 1), the data are read as for the airborne release set using the format of Table 3.5.

TABLE 3.5. Radionclide Release Data Format

Parameter	Columns	Format	Description
NNAT	1-5	I5	Number of radionuclides for which activity release data are supplied
E	1-2	A2	Element symbol for the current radionuclide
A	3-8	A6	Atomic weight symbol for the current radionuclide
	9-10	2X	Blank
NT	11-15	I5	Number of times for which release rates will be supplied, NT $\leq$ 300. When NT $\leq$ 0, reading of activity release data is terminated. NT determines the number of data records to be read.
TA(i)	1-10	E10.2	Time at which the current release rate is defined. Years since start of release and based on parameter TZR.
C(i)	11-20	E10.2	Release rate, Ci/yr, for the current radionuclide at time TA(i).

Calculations are performed after input of necessary data. If additional cases are to be considered, the same data formats are used based on new values given for the control parameters in the new NAMELIST set. Each succeeding case starts with input of a title record and a NAMELIST INPUT set.

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4.0 SYSTEM REQUIREMENTS

The GENII Software Package will run on an IBM-PC AT or equivalent computer configured with an 80287 math co-processor, 640 kilobytes random-access memory, a minimum of 5 megabytes on-line disk storage, and operating under IBM DOS 3.1 or newer version.

Portions of the GENII Software Package have been tested on a number of IMB-PC/AT compatible machines. Versions of GENII have been established on microcomputers manufactured by GRID, NEC, Hewlett-Packard, and IBM. The IBM machines have included the new PS/2 System 50 and System 80. No machine-based incompatabilities have been found.

The GENII Software System is distributed on either 5.25-inch, 1.2 megabyte disks, or on 3.5-inch, 720 kilobyte disks. An automatic install procedure has been included with the software. To install the GENII Software Package, do the following:

1. Insert the GENII Distribution Disk # 1 in the A: floppy disk drive.
2. Type **A:** and press **Enter**.
3. Type: **INSTALL n:**, where **n** designates the hard disk you wish GENII to be installed on, and press **Enter**.
4. Respond as requested by the install procedure.

The installation procedure will create a subdirectory named GENII on the designated drive and then copy files into that subdirectory.

For the GENII Software Package to function properly, the following commands must be in the **CONFIG.SYS** file in the root directory of the disk drive which is used to boot the system:

```
FILES=20
BUFFERS=24
DEVICE=ANSI.SYS
```

Refer to the IBM DOS reference manual (IBM 1985) for details on installing these commands.

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5.0 QUALITY ASSURANCE RELATED TOPICS

The GENII software package was developed in a framework for complying with the requirements of ANSI/ASME NQA-1-1983, Quality Assurance Program Requirements for Nuclear Power Plants, Supplement 3S-1, Supplementary Requirements for Design Control. NQA-1 specifies that for hardware design control, the following shall be addressed:

- design input
- design process, including design analysis
- design verification
- change control
- interface control
- documentation and records.

The QA procedures used during the development of the GENII software package are an interpretation of these hardware requirements for software.

Design input is specified through research project planning documents. This requirement was met through the preparation of the System Design Requirements presented as the Appendix to Volume 1 (Napier et al. 1988a).

The design process consisted of developing and internally testing software, developing test cases, and documenting software in accordance with the design input. The GENII package has been extensively tested and verified by hand, using the hand calculation worksheets of Volume 3 (Napier et al. 1988b), and benchmarked against similar Hanford environmental dosimetry programs. A 10-volume set of test documentation is available for review from the authors upon request. The design process concluded with analysis of the final design by means of a Final Internal Development Review (FIDR). Two external peer reviews were held, as described in Section 1.2 of Volume 1; these constitute the FIDR for the GENII package.

Following the FIDR, the GENII code was placed under configuration management. Through this management, all changes and versions have been controlled and documented. Change control has been instituted; only authorized and approved changes can be made to the working versions. A list of users is maintained, and revisions are distributed to this list when necessary.

Additional volumes of change documentation records are available. This three-volume set contains all necessary documentation of the code, models, and implementation methods for GENII Version 1.359. Further revisions will be documented, and revised documentation will be issued if necessary.

In addition to the development requirements, NQA-1 addresses applications of software. The controlled versions of the code may be obtained from the authors, with sufficient documentation to assure correctness of the proposed application. Users must maintain applications records logs for all applications of the code outside of the Hanford Environmental Dosimetry Upgrade Project.

The GENII Software Package is made up of six programs written in FORTRAN and one written in compiled BASIC. The FORTRAN programs are compiled using the Lahey F77L compiler (Lahey Computer Systems 1986). The BASIC program is distributed in a version compiled with the Microsoft QuickBASIC 3.0 compiler (Microsoft 1987). The BASIC program uses modules and subroutines from the Komputerwerk FINALLY! and FINALLY! Modules libraries (Komputerwerk 1986a, 1986b). The GENII System codes have been developed and tested using these products, and unanticipated problems may occur if other compilers are used.

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APPENDIX A

SAMPLE PROBLEM INPUT AND OUTPUT

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APPENDIX A

SAMPLE PROBLEM INPUT AND OUTPUT

Example input files and the resultant code outputs are listed in this appendix. Seven sample problems are presented with all required external data files. These seven examples provide a glimpse of the range of capabilities of the GENII package. They are, however, by no means exhaustive, and within the limitations of the printed page they can only be used as indicators of the types of calculations that may be performed using the GENII system. Each sample problem is briefly described, and the salient parts of the output are noted. These sample outputs may be used by persons installing the GENII package to compare it to calculated results to assure that the codes are functioning properly on particular hardware configurations.

A.1 GENII SAMPLE PROBLEM 1

The first sample problem represents a chronic release of a spectrum of radionuclides to the atmosphere through a stack with an effective height of 89 meters. The release is assumed to last for a period of one year, exposures of the public surrounding the release point are assessed for the 1-year release, and a 50-year dose commitment is calculated. Because this is a population dose calculation, an external data file providing the population distribution is needed. The air submersion dose is to be calculated using the finite-plume model. Therefore, an external data file of the joint frequency of occurrence of wind speed, wind direction, and stability class is also required. People are exposed via air submersion, inhalation, direct exposure to deposited materials on the ground, and ingestion of food crops and animal products.

The GENII input file created by APPRENTICE for this scenario is presented as Exhibit A.1. The required population data file, to be copied into the POP.IN file buffer, is presented in Exhibit A.2. The required joint frequency data file, to be copied into the JOINTFRE.IN file buffer, is presented as Exhibit A.3. These are typical working data files similar to those used for dose calculations for Hanford annual environmental reports.

EXHIBIT A.1. GENII Input File - Sample Problem 1

```
######################### Program GENII Input File ############# 8 Mar 88 ####
Title: GENII Sample Problem 1
      \genii\sam\sample1.in                        Created on 08-05-1988 at 15:10
OPTIONS======================== Default ======================================
F    Near-field scenario?       (Far-field)    NEAR-FIELD: narrowly-focused
T    Population dose?          (Individual)                release, single site
F    Acute release?              (Chronic)     FAR-FIELD:  wide-scale release,
     Average Individual data set used                      multiple sites
                              Complete                                 Complete
TRANSPORT OPTIONS=========== Section    EXPOSURE PATHWAY OPTIONS===== Section
T  Air Transport                1       T  Finite plume, external        5
F  Surface Water Transport      2       F  Infinite plume, external      5
F  Biotic Transport (near-field) 3      T  Ground, external              5
F  Waste Form Degradation (near) 4      F  Recreation, external          5
                                        T  Inhalation uptake             6
REPORT OPTIONS======================    F  Drinking water ingestion      7,8
T  Report AEDE only                     F  Aquatic foods ingestion       7,8
F  Report by radionuclide               T  Terrestrial foods ingestion   7,9
F  Report by exposure pathway           T  Animal product ingestion      7,10
F  Debug report on screen               F  Inadvertent soil ingestion

INVENTORY ####################################################################

 4   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 0   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

     --------|----Release Terms------|----------Basic Concentrations---------|
     Use when|  transport selected   | near-field scenario, optionally       |
     --------|-----------------------|---------------------------------------|
     Release |       Surface Buried  |       Surface Deep    Ground  Surface |
     Radio-  |Air    Water   Waste   |Air    Soil    Soil    Water   Water   |
     nuclide |/yr    /yr     /m3     |/L     /unit   /m3     /L      /L      |
     --------|------- ------- ------- |------- ------- ------- ------- -------|
     H 3      7.0E+01
     C 14     1.0E+00
     KR85     7.0E+04
     SR90     2.0E-04
     NB95     1.0E-05
     RU103    2.0E-04
     RU106    2.0E-02
     SB125    1.0E-03
     I 129    5.0E-01
     I 131    2.0E-04
     CS134    1.0E-05
     CS137    4.0E-05
     PM147    1.0E-03
     PB212    2.0E-01
     BI212    1.0E-01
     U 234    2.0E-06
```

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EXHIBIT A.1. (contd)

```
U 235    7.0E-08
U 238    2.0E-06
PU238    3.0E-05
PU241    3.0E-03
AM241    1.0E-04
PU239    4.0E-04

--------|----Derived Concentrations-----|
Use when|  measured values are known    |
--------|-------------------------------|
Release |Terres. Animal  Drink   Aquatic|
Radio-  |Plant   Product Water   Food   |
nuclide |/kg     /kg     /L      /kg    |
--------|------- ------- ------- -------|


TIME #########################################################################

1    Intake ends after (yr)
50   Dose calc. ends after (yr)
1    Release ends after (yr)
0    No. of years of air deposition prior to the intake period
0    No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) #####################################

 1         Definition option: 1-Use population grid in file POP.IN
0                             2-Use total entered on this line

NEAR-FIELD SCENARIOS #########################################################

           Prior to the beginning of the intake period: (yr)
0            When was the inventory disposed?  (Package degradation starts)
0            When was LOIC?  (Biotic transport starts)
0          Fraction of roots in upper soil (top 15 cm)
0          Fraction of roots in deep soil
0          Manual redistribution: deep soil/surface soil dilution factor

TRANSPORT ####################################################################
           ====AIR TRANSPORT=====================================SECTION 1=====
                   0-Calculate PM             |
0          Option: 1-Use chi/Q or PM value    |T            Stack release (T/F)
                   2-Select MI dist & dir     |89.0         Stack height (m)
                   3-Specific MI dist & dir   |0            Stack flow (m3/sec
0          Chi/Q or PM value                  |0            Stack radius (m)
16         MI sector index (1=S)              |0            Effluent temp. (C)
5.3E+4     MI distance from release point (m)
T          Use joint frequency data, otherwise chi/Q grid
```

EXHIBIT A.1. (contd)

```
            ====SURFACE WATER TRANSPORT==========================SECTION 2=====
0           Mixing ratio model: 0-use value, 1-river, 2-lake, 3-river flow
0           Mixing ratio, dimensionless
0           Average river flow rate for: MIXFLG=0,3 (m3/s), MIXFLG=1,2 (m/s),
0           Transit time to irrigation withdrawal location (hr)
            If mixing ratio model > 0:
0             Rate of effluent discharge to receiving water body (m3/s)
0             Longshore distance from release point to usage location (m)
0             Offshore distance to the water intake (m)
0             Average water depth in surface water body (m)
0             Average river width (m), MIXFLG=1 only
0             Depth of effluent discharge point to surface water (m), lake only

            ====WASTE FORM AVAILABILITY==========================SECTION 3=====
0           Waste form/package half life, (yr)
0           Waste thickness, (m)
0           Depth of soil overburden, m

            ====BIOTIC TRANSPORT OF BURIED SOURCE================SECTION 4=====
T           Consider during inventory decay/build-up period (T/F)?
T           Consider during intake period (T/F)?  | 1-Arid non agricultural
0           Pre-Intake site condition.............| 2-Humid non agricultural
                                                  | 3-Agricultural

EXPOSURE ##################################################################

            ====EXTERNAL EXPOSURE================================SECTION 5=====
            Exposure time:                    |   Residential irrigation:
8766.0        Plume (hr)                      | T        Consider: (T/F)
2920.0        Soil contamination (hr)         | 0        Source: 1-ground water
0             Swimming (hr)                   |                  2-surface water
0             Boating (hr)                    | 0        Application rate (in/yr)
0             Shoreline activities (hr)       | 0        Duration (mo/yr)
0           Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
0           Transit time for release to reach aquatic recreation (hr)
0           Average fraction of time submersed in acute cloud (hr/person-hr)

            ====INHALATION=======================================SECTION 6=====
8766.0      Hours of exposure to contamination per year
0           0-No resus-  1-Use Mass Loading          2-Use Anspaugh model
0             pension      Mass loading factor (g/m3)   Top soil available (cm)

            ====INGESTION POPULATION=============================SECTION 7=====
 1          Atmospheric production definition (select option):
0             0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line
              1-Use population-weighted chi/Q
              2-Use uniform production
              3-Use chi/Q and production grids (PRODUCTION will be overridden)
```

EXHIBIT A.1. (contd)

0 Population ingesting aquatic foods, 0 defaults to total (person)
0 Population ingesting drinking water, 0 defaults to total (person)
F Consider dose from food exported out of region (default=F)

Note below: S* or Source: 0-none, 1-ground water, 2-surface water
3-Derived concentration entered above

==== AQUATIC FOODS / DRINKING WATER INGESTION=========SECTION 8====

F Salt water? (default is fresh)

USE ? T/F	FOOD TYPE	TRAN-SIT hr	PROD-UCTION kg/yr	-CONSUMPTION- HOLDUP da	RATE kg/yr	DRINKING WATER	
F	FISH	0.00	0.0E+00	0.00	0.0	0	Source (see above)
F	MOLLUS	0.00	0.0E+00	0.00	0.0	T	Treatment? T/F
F	CRUSTA	0.00	0.0E+00	0.00	0.0	0	Holdup/transit(da)
F	PLANTS	0.00	0.0E+00	0.00	0.0	0	Consumption (L/yr)

====TERRESTRIAL FOOD INGESTION======================SECTION 9=====

USE ? T/F	FOOD TYPE	GROW TIME da	S *	--IRRIGATION-- RATE in/yr	TIME mo/yr	YIELD kg/m2	PROD-UCTION kg/yr	--CONSUMPTION-- HOLDUP da	RATE kg/yr
T	LEAF V	90.00	0	0.0	0.0	1.5	0.0E+00	14.0	15.0
T	ROOT V	90.00	0	0.0	0.0	4.0	0.0E+00	14.0	140.0
T	FRUIT	90.00	0	0.0	0.0	2.0	0.0E+00	14.0	64.0
T	GRAIN	90.00	0	0.0	0.0	0.8	0.0E+00	180.0	72.0

====ANIMAL PRODUCTION CONSUMPTION===================SECTION 10====

USE ? T/F	FOOD TYPE	---HUMAN---- CONSUMPTION RATE kg/yr	HOLDUP da	TOTAL PROD-UCTION kg/yr	DRINK WATER CONTAM FRACT.	-------------STORED FEED------------- DIET FRAC-TION	GROW TIME da	S *	-IRRIGATION-- RATE in/yr	TIME mo/yr	YIELD kg/m3	STOR-AGE da
T	BEEF	70.0	34.0	0.00	0.00	0.25	90.0	0	0.0	0.00	0.80	180.0
T	POULTR	8.5	34.0	0.00	0.00	1.00	90.0	0	0.0	0.00	0.80	180.0
T	MILK	230.0	4.0	0.00	0.00	0.25	45.0	0	0.0	0.00	2.00	100.0
T	EGG	20.0	18.0	0.00	0.00	1.00	90.0	0	0.0	0.00	0.80	180.0
						-------------FRESH FORAGE------------						
	BEEF					0.75	45.0	0	0.0	0.00	2.00	100.0
	MILK					0.75	30.0	0	0.0	0.00	1.50	0.0

##

EXHIBIT A.2. Required GENII Population Data File - Sample Problem 1

```
200 Area Population (Sommer, Rau, and Robinson, PNL-4010)
Created 5-Nov-87, updated 19-Feb-88 RAP

  0     0     0     0     0     0   1532   1489    195   1799
  0     0     0     0     0     0    905   5283    652    129
  0     0     0     0     0     0   1190  19786   2182    459
  0     0     0     0     0     5   1840   5063  15088   4573
  0     0     0     0     0    32    648    949   6874  78635
  0     0     0     0     0    73    444    802    833   2833
  0     0     0     0     0     0    555    398    493   1454
  0     0     0     0     0     0    246    456    864   4521
  0     0     0     0     0     0    174   1124    772   1957
  0     0     0     0     0     0     92    656   5547  14822
  0     0     0     0     0     0    262   5930   2963    596
  0     0     0     0     0     0    235    773   2366    435
  0     0     0     0     0     0    340   1329   1659    588
  0     0     0     0     0     0    283   1374    230    652
  0     0     0     0     0     0   6757  48661  50519   3474
  0     0     0     0     0     0   1997  13161   2717   5218
```

EXHIBIT A.3. Required GENII Joint Frequency Data File - Sample Problem 1

```
200 AREA - 89 M - Pasquill A - F (1983 - 1987 Average)
Created 10-Mar-88 RAP
  8    6    1    1    89.0
 .89    2.65   4.7    7.15   9.8    12.7   15.6   19.0
 0.30 0.27 0.29 0.19 0.23 0.20 0.13 0.12 0.11 0.08 0.06 0.07 0.10 0.08 0.14 0.13
 0.17 0.10 0.09 0.09 0.10 0.05 0.05 0.03 0.05 0.03 0.03 0.02 0.04 0.04 0.04 0.07
 0.16 0.12 0.10 0.06 0.08 0.06 0.07 0.03 0.02 0.01 0.01 0.03 0.04 0.03 0.06 0.09
 0.77 0.51 0.41 0.35 0.49 0.49 0.44 0.32 0.36 0.19 0.20 0.28 0.43 0.47 0.59 0.58
 0.29 0.14 0.12 0.12 0.21 0.21 0.31 0.25 0.31 0.19 0.22 0.25 0.46 0.39 0.39 0.25
 0.24 0.15 0.11 0.12 0.20 0.18 0.25 0.23 0.27 0.20 0.25 0.31 0.54 0.45 0.45 0.31
 0.94 0.48 0.37 0.40 0.58 0.48 0.41 0.35 0.35 0.22 0.31 0.24 0.29 0.29 0.59 0.77
 0.27 0.15 0.12 0.11 0.13 0.13 0.07 0.08 0.09 0.05 0.08 0.04 0.08 0.15 0.24 0.23
 0.22 0.09 0.07 0.07 0.11 0.07 0.10 0.05 0.07 0.04 0.05 0.03 0.04 0.09 0.19 0.22
 0.65 0.41 0.26 0.27 0.39 0.35 0.34 0.23 0.28 0.22 0.25 0.29 0.55 0.85 1.11 0.75
 0.26 0.09 0.08 0.09 0.23 0.28 0.22 0.25 0.32 0.20 0.28 0.47 0.76 0.82 0.61 0.37
 0.22 0.08 0.08 0.07 0.12 0.20 0.24 0.22 0.35 0.34 0.40 0.67 1.14 0.88 0.70 0.37
 0.43 0.24 0.16 0.11 0.12 0.10 0.11 0.10 0.15 0.20 0.35 0.38 0.29 0.32 0.63 0.39
 0.08 0.06 0.04 0.03 0.04 0.02 0.04 0.04 0.02 0.06 0.06 0.08 0.07 0.11 0.17 0.09
 0.04 0.03 0.01 0.02 0.01 0.00 0.02 0.01 0.02 0.03 0.04 0.07 0.08 0.06 0.15 0.09
 0.23 0.12 0.05 0.06 0.09 0.12 0.17 0.14 0.18 0.15 0.25 0.32 0.62 1.09 1.06 0.37
 0.15 0.06 0.05 0.05 0.07 0.10 0.13 0.16 0.22 0.16 0.29 0.59 1.27 1.26 0.74 0.30
 0.09 0.05 0.04 0.03 0.07 0.07 0.21 0.18 0.28 0.27 0.38 0.83 1.31 1.21 0.86 0.31
 0.08 0.11 0.05 0.02 0.01 0.00 0.02 0.03 0.04 0.10 0.30 0.38 0.24 0.26 0.43 0.10
 0.03 0.02 0.01 0.00 0.00 0.00 0.01 0.01 0.02 0.04 0.04 0.10 0.05 0.07 0.10 0.03
```

EXHIBIT A.3. (contd)

0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.03	0.06	0.06	0.05	0.10	0.01
0.11	0.11	0.04	0.02	0.02	0.03	0.08	0.09	0.10	0.17	0.25	0.37	0.62	0.97	0.77	0.16
0.09	0.04	0.02	0.01	0.01	0.05	0.07	0.08	0.11	0.13	0.25	0.41	1.17	1.24	0.73	0.16
0.04	0.01	0.02	0.01	0.03	0.05	0.10	0.16	0.12	0.10	0.20	0.51	0.88	0.92	0.61	0.12
0.01	0.02	0.02	0.02	0.00	0.00	0.00	0.01	0.01	0.03	0.09	0.17	0.10	0.11	0.30	0.04
0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.04	0.02	0.03	0.06	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.02	0.02	0.03	0.05	0.01
0.02	0.03	0.01	0.01	0.00	0.00	0.02	0.03	0.08	0.14	0.20	0.20	0.36	0.74	0.47	0.03
0.02	0.02	0.01	0.00	0.00	0.00	0.04	0.04	0.06	0.07	0.14	0.18	0.40	0.79	0.50	0.06
0.01	0.00	0.01	0.00	0.00	0.01	0.05	0.05	0.02	0.02	0.04	0.12	0.20	0.31	0.16	0.04
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.10	0.04	0.05	0.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.01	0.01	0.02	0.03	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.03	0.00
0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.05	0.11	0.14	0.12	0.19	0.47	0.47	0.02
0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.01	0.05	0.05	0.09	0.12	0.18	0.37	0.31	0.03
0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.03	0.04	0.04	0.09	0.05	0.01
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.01	0.00	0.03	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.07	0.05	0.04	0.21	0.20	0.01
0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.03	0.05	0.10	0.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.02	0.01	0.01	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.04	0.07	0.03	0.05	0.08	0.04	0.01
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.04	0.02	0.00	0.05	0.06	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00

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They provide the user with examples of the types and magnitude of data that might be required.

The output of the GENII simulation based on the above input is presented as Exhibit A.4. This is a fairly typical GENII output; it consists of three separate portions, which can be identified by the page number in the upper right hand portion of the printed output. The portion identified by page numbers A.n is the Quality Assurance output portion. The input values and scenario description flags are repeated in the output to allow checking of the calculation assumptions. The portion identified by page numbers B.n includes the results of the (optional) atmospheric dispersion calculations. In the case of Sample Problem 1, this is a one-page report providing the calculated population-weighted atmospheric dispersion factor.

The portion identified with page numbers C.n includes the actual dose calculation results. For Sample Problem 1, this consists of three summary pages. The first, page C.1, illustrates the effective dose equivalent summary calculation, from which individual organ doses may be obtained. This page also provides a summary table of the dominant organ, dominant radionuclide, and dominant exposure pathway. The second page, C.2, illustrates the dose assembly matrix (defined in Figure 3.6 of Volume 1 in this GENII series) from which the annual dose, effective dose equivalent, cumulative dose, and maximum annual dose may be obtained in a single calculational run. In this example, because the exposure time was only one year, the contributions shown in this dose matrix for years two and three are set to zero. The third page, C.3, provides the dose contribution by radionuclide, as a function of ingestion, inhalation, and external exposure.

A.2 GENII SAMPLE PROBLEM 2

The second sample problem represents the calculation of the dose to a maximally exposed individual from the chronic release of radionuclides into surface water. The individual is assumed to drink river water, to consume fish from the river, to make recreational use of the river, and to irrigate crops and animal feed with the water. External doses result from exposure to the water, to sediments, and to irrigated soil. No contribution to dose is considered from inhalation, that pathway is specifically turned off.

EXHIBIT A.4. GENII Output File Sample Problem 1

```
---------------------------------------------------------------------------
                    GENII  Dose Calculation Program
                      (Version 1.351 30-Aug-88)

Case title:   GENII Sample Problem 1

Executed on:  09/27/88 at 16:59:06                            Page A.  1
---------------------------------------------------------------------------

          This is a far-field (wide-scale release, multiple site) scenario.
          Release is chronic
          Dose to exposed population of  3.409E+05

          THE FOLLOWING TRANSPORT MODES ARE CONSIDERED
               Air

          THE FOLLOWING EXPOSURE PATHS ARE CONSIDERED:
               Finite plume, external
               Ground, external
               Inhalation uptake
               Terrestrial foods ingestion
               Animal product ingestion

          THE FOLLOWING TIMES ARE USED:
               Intake ends after (yr):                1.0
               Dose calculations ends after (yr):    50.0
               Release ends after (yr):               1.0

========== FILE NAMES AND TITLES OF FILES/LIBRARIES USED =====================

                                      \genii\sam\sample1.in            9-27-88
GENII Default Parameter Values (3-Aug-88 RAP)                          8-12-88
RMDLIB - Radionuclide Master Library  (29-Aug-88 RAP)                  8-29-88
Food Transfer Factor Library - (RAP  29-Aug-88) (UPDATED LEACHING FA   8-29-88
External Dose Factors for GENII in person-Sv/yr per Bq/n (28-Aug-88    8-29-88
Internal Yearly Dose Increments  (Sv/Bq)  29-Aug-88  RAP               8-29-88
200 Area Population (Sommer, Rau, and Robinson, 1981, PNL-4010)

200 AREA - 89 M - Pasquill A - F (1983 - 1987 Average)

==============================================================================

          -------- ----Release Terms------
          Release          Surface Buried
          Radio-   Air     Water   Source
          nuclide  Ci/yr   Ci/yr   Ci/m3
          -------- ------- ------- -------
          H 3      7.0E+01 0.0E+00 0.0E+00
          C 14     1.0E+00 0.0E+00 0.0E+00
```

KR85	7.0E+04	0.0E+00	0.0E+00
SR90	2.0E-04	0.0E+00	0.0E+00
NB95	1.0E-05	0.0E+00	0.0E+00
RU103	2.0E-04	0.0E+00	0.0E+00
RU106	2.0E-02	0.0E+00	0.0E+00
SB125	1.0E-03	0.0E+00	0.0E+00
I 129	5.0E-01	0.0E+00	0.0E+00
I 131	2.0E-04	0.0E+00	0.0E+00
CS134	1.0E-05	0.0E+00	0.0E+00
CS137	4.0E-05	0.0E+00	0.0E+00
PM147	1.0E-03	0.0E+00	0.0E+00
PB212	2.0E-01	0.0E+00	0.0E+00
BI212	1.0E-01	0.0E+00	0.0E+00
U 234	2.0E-06	0.0E+00	0.0E+00
U 235	7.0E-08	0.0E+00	0.0E+00
U 238	2.0E-06	0.0E+00	0.0E+00
PU238	3.0E-05	0.0E+00	0.0E+00
PU241	3.0E-03	0.0E+00	0.0E+00
AM241	1.0E-04	0.0E+00	0.0E+00
PU239	4.0E-04	0.0E+00	0.0E+00

========== AIR TRANSPORT ==

Joint frequency data input.

8.9E+01 Effective stack height (m)

========== EXTERNAL EXPOSURE ==

8.8E+03 Hours of exposure to plume

2.9E+03 Hours of exposure to ground contamination

========== INHALATION ===

8.8E+03 Hours of exposure to contamination per year

Resuspension not considered

========== INGESTION POPULATION ===

1 Atmospheric production definition: 1 - Use population-weighted chi/Q

Food production in region assumed to equal consumption.

========== TERRESTRIAL FOOD INGESTION ===

	GROW	--IRRIGATION--				PROD-	--CONSUMPTION--	
FOOD	TIME	S	RATE	TIME	YIELD	UCTION	HOLDUP	RATE
TYPE	d	*	in/yr	mo/yr	kg/m2	kg/yr	d	kg/yr
Leaf Veg	90.0	0	0.0	0.0	1.5		14.0	1.5E+01
Oth. Veg	90.0	0	0.0	0.0	4.0		14.0	1.4E+02
Fruit	90.0	0	0.0	0.0	2.0		14.0	6.4E+01
Cereals	90.0	0	0.0	0.0	0.8		180.0	7.2E+01

EXHIBIT A.4. (contd)

========== ANIMAL FOOD INGESTION ==========

FOOD TYPE	---HUMAN---- CONSUMPTION RATE kg/yr	HOLDUP d	TOTAL PRODUCTION kg/yr	DRINK WATER CONTAM FRACT.	DIET FRACTION	GROW TIME d	S *	-IRRIGATION-- RATE in/yr	TIME mo/yr	YIELD kg/m3	STORAGE d
					---STORED FEED---						
Meat	7.0E+01	34.0		0.00	0.3	90.00	0	0.0	0.0	0.80	180.0
Poultry	8.5E+00	34.0		0.00	1.0	90.00	0	0.0	0.0	0.80	180.0
Cow Milk	2.3E+02	4.0		0.00	0.3	45.00	0	0.0	0.0	2.00	100.0
Eggs	2.0E+01	18.0		0.00	1.0	90.00	0	0.0	0.0	0.80	180.0
					---FRESH FORAGE---						
Meat					0.75	45.0	0	0.0	0.0	2.00	100.0
Cow Milk					0.75	30.0	0	0.0	0.0	1.50	0.0

==========

Input prepared by: ______________________ Date: __________

Input checked by: ______________________ Date: __________

==========

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 1

Executed on: 09/27/88 at 17:01:43 Page B. 1

1.6E-03 Population-weighted chi/Q

Source area external dose modification factor: 1.00000

EXHIBIT A.4. (contd)

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 1

Executed on: 09/27/88 at 17:07:11 Page C. 1

Release period: 1.0
Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Person-rem

Organ	Committed Dose Equivalent	Weighting Factors	Weighted Dose Equivalent
Gonads	9.8E-02	2.5E-01	2.4E-02
Breast	1.0E-01	1.5E-01	1.5E-02
R Marrow	2.1E-01	1.2E-01	2.6E-02
Lung	4.0E-01	1.2E-01	4.9E-02
Thyroid	2.0E+02	3.0E-02	6.1E+00
Bone Sur	1.3E+00	3.0E-02	3.8E-02
Liver	1.9E-01	6.0E-02	1.2E-02
LL Int.	1.0E-01	6.0E-02	6.2E-03
UL Int.	9.5E-02	6.0E-02	5.7E-03
S Int.	9.3E-02	6.0E-02	5.6E-03
Stomach	5.9E-02	6.0E-02	3.5E-03

Internal Effective Dose Equivalent 6.3E+00
External Dose 3.3E-02

Annual Effective Dose Equivalent 6.3E+00

Controlling Organ: Thyroid
Controlling Pathway: Ing
Controlling Radionuclide: I 129

Inhalation EDE: 1.3E-01
Ingestion EDE: 6.1E+00

```
---------------------------------------------------------------------------------
                          GENII  Dose Calculation Program
                           (Version 1.351 30-Aug-88)

Case title:    GENII Sample Problem 1

Executed on:   09/27/88 at 17:07:11                                    Page C.  2
---------------------------------------------------------------------------------

Release period:                                                   1.0
Uptake/exposure period:                                           1.0
Dose commitment period:                                          50.0
Dose units:                                                  Person-rem



             Dose Commitment Year
                   1         2         3     ...

Internal  :  ________________________________
Intake    : |
Year:     3 |                      0.0E+00   ...
            |                         +
          2 |            0.0E+00   0.0E+00   ...                 Internal
            |               +         +                          Effective
          1 | 5.5E+00 + 6.0E-01 + 6.9E-02 + ...  =  6.3E+00      Dose
                                                                 Equivalent
               ||        ||        ||
Internal                                                         Cumulative
Annual        5.5E+00 + 6.0E-01 + 6.9E-02 + ...  =  6.3E+00      Internal
Dose                                                             Dose
                 +         +         +                 +
External
Annual        3.3E-02   0.0E+00   0.0E+00   ...     3.3E-02
Dose
               ||        ||        ||                 ||
Annual                                                           Cumulative
Dose          5.6E+00 + 6.0E-01 + 6.9E-02 + ...  =  6.3E+00      Dose

                                                                 Maximum
                                                    5.6E+00      Annual
                                                                 Dose Occurred
                                                                 In Year  1
_________________________________________________________________________
```

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 1
Executed on: 09/27/88 at 17:07:11 Page C. 3

Release period: 1.0
Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Person-rem

Radio-nuclide	Inhalation Effective Dose Equivalent	Ingestion Effective Dose Equivalent	External Dose	Internal Effective Dose Equivalent	Annual Effective Dose Equivalent
H 3	2.5E-03	1.3E-02	0.0E+00	1.6E-02	1.6E-02
C 14	8.4E-04	5.1E-02	0.0E+00	5.2E-02	5.2E-02
KR 85	0.0E+00	0.0E+00	3.3E-02	0.0E+00	3.3E-02
SR 90	1.7E-05	5.8E-05	2.9E-10	7.6E-05	7.6E-05
Y 90	2.6E-08	3.0E-06	1.5E-08	3.0E-06	3.1E-06
NB 95	2.4E-08	2.3E-08	1.6E-08	4.7E-08	6.3E-08
RU 103	7.7E-07	5.6E-07	2.3E-07	1.3E-06	1.6E-06
PD 103	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
RH 103M	3.5E-10	8.8E-09	1.0E-10	9.2E-09	9.3E-09
RU 106	4.0E-03	7.8E-04	4.4E-05	4.8E-03	4.8E-03
SB 125	5.3E-06	4.3E-06	5.3E-06	9.6E-06	1.5E-05
TE 125M	1.1E-09	1.6E-06	4.8E-09	1.6E-06	1.6E-06
I 129	3.3E-02	6.1E+00	7.6E-05	6.1E+00	6.1E+00
I 131	2.6E-06	1.5E-04	3.1E-07	1.5E-04	1.5E-04
XE 131M	0.0E+00	0.0E+00	2.1E-11	0.0E+00	2.1E-11
CS 134	1.8E-07	4.3E-06	1.8E-07	4.5E-06	4.7E-06
CS 137	4.6E-07	1.3E-05	3.0E-07	1.3E-05	1.3E-05
PM 147	1.7E-05	1.9E-06	9.4E-11	1.9E-05	1.9E-05
SM 147	7.5E-17	4.0E-16	0.0E+00	4.7E-16	4.7E-16
PB 212	1.2E-02	3.1E-04	5.9E-06	1.2E-02	1.2E-02
BI 212	1.3E-03	7.6E-06	5.1E-05	1.3E-03	1.3E-03
U 234	1.1E-04	7.3E-08	2.2E-12	1.1E-04	1.1E-04
U 235	3.7E-06	2.6E-09	6.7E-11	3.7E-06	3.7E-06
TH 231	2.1E-12	1.3E-10	4.0E-12	1.3E-10	1.3E-10
PA 231	1.0E-14	3.9E-12	2.3E-16	3.9E-12	3.9E-12
AC 227	1.2E-19	1.5E-14	6.8E-21	1.5E-14	1.5E-14
TH 227	0.0E+00	2.8E-17	5.9E-18	2.8E-17	3.4E-17
FR 223	0.0E+00	1.0E-19	3.6E-20	1.0E-19	1.4E-19
RA 223	0.0E+00	2.1E-16	1.5E-17	2.1E-16	2.3E-16
U 238	1.0E-04	6.7E-08	1.2E-12	1.0E-04	1.0E-04
TH 234	1.2E-10	2.0E-08	4.6E-10	2.0E-08	2.0E-08

EXHIBIT A.4. (contd)

PA 234	9.3E-16	5.1E-12	7.0E-11	5.1E-12	7.5E-11
PU 238	3.7E-03	1.2E-05	1.8E-11	3.7E-03	3.7E-03
PU 241	6.4E-03	2.5E-05	1.4E-15	6.4E-03	6.4E-03
AM 241	1.9E-02	4.4E-04	6.3E-09	1.9E-02	1.9E-02
PU 239	5.1E-02	1.8E-04	2.7E-10	5.2E-02	5.2E-02

All data required to perform this calculation is contained in the input file, no additional data files are needed.

The input file to perform this calculation is provided as Exhibit A.5. The output resulting from the calculation is given in Exhibit A.6.

The output of GENII Sample Problem 2 is similar in form to that of Sample Problem 1. Only two of the output portions are listed, those labeled with page numbers A.n and C.n. As with problem 1, those labeled with A.n page numbers are the quality assurance pages, repeating the input for record purposes. Those labeled C.n are the dose results. No pages of the sequence B.n were produced in this example, because no atmospheric dispersion calculations were requested.

For brevity in this document, pages C.1 and C.2 have been omitted. The formats of these pages are identical with those provided in Exhibit A.4 for Sample Problem 1; the pages provide the effective dose equivalent summary and the dose assembly matrix grid.

The page labeled C.3 in Exhibit A.6 provides the doses for Sample Problem 2 listed by exposure pathway for the organs for which dose is calculated, for the internal exposures. The page labeled C.4 provides the external doses by exposure pathway. The organ-related information has been included in the doses presented through the derivation of the dose factors, as described in Section 4 of Volume 1 of this GENII series, and so it is not reported. Internal doses to the organs are reported by radionuclide on page C.5. A final page, C.6, has been omitted from this report. Its format is the same as that shown for page C.3 of Sample Problem 1, the total dose listed by radionuclide.

A.3 GENII SAMPLE PROBLEM 3

The third sample problem represents the prospective calculation of the impacts to the population in a selected downwind sector of an acute accidental release of radionuclides to air. Rather than having the code calculate the 95th percentile value of the air concentration, a value of the time-integrated atmospheric dispersion parameter, E/Q, is input to this sample. Because the E/Q is input, the infinite-plume submersion model must be used.

EXHIBIT A.5. GENII Input File- Sample Problem 2

```
######################### Program GENII Input File ############# 7 Mar 88 ####
Title: GENII Sample Problem 2
      \genii\sam\sample2.in                         Created on 08-05-1988 at 15:41
OPTIONS======================== Default =====================================
F    Near-field scenario?       (Far-field)    NEAR-FIELD: narrowly-focused
F    Population dose?          (Individual)                release, single site
F    Acute release?              (Chronic)     FAR-FIELD:  wide-scale release,
     Maximum Individual data set used                      multiple sites
                               Complete                                  Complete
TRANSPORT OPTIONS============ Section     EXPOSURE PATHWAY OPTIONS===== Section
F  Air Transport                  1       F  Finite plume, external        5
T  Surface Water Transport        2       F  Infinite plume, external      5
F  Biotic Transport (near-field)  3       T  Ground, external              5
F  Waste Form Degradation (near)  4       T  Recreation, external          5
                                          F  Inhalation uptake             6
REPORT OPTIONS=====================       T  Drinking water ingestion      7,8
T  Report AEDE only                       T  Aquatic foods ingestion       7,8
T  Report by radionuclide                 T  Terrestrial foods ingestion   7,9
T  Report by exposure pathway             T  Animal product ingestion      7,10
F  Debug report on screen                 F  Inadvertent soil ingestion

INVENTORY ####################################################################

 4   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 0   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

     --------|----Release Terms------|----------Basic Concentrations---------|
     Use when|  transport selected   |  near-field scenario, optionally      |
     --------|-----------------------|---------------------------------------|
     Release |       Surface Buried  |       Surface Deep    Ground  Surface |
     Radio-  |Air    Water   Waste   |Air    Soil    Soil    Water   Water   |
     nuclide |/yr    /yr     /m3     |/L     /unit   /m3     /L      /L      |
     --------|------- ------- -------|------- ------- ------- ------- -------|
     H 3             5.3E+03
     I 129           9.0E-03

     --------|----Derived Concentrations-----|
     Use when|  measured values are known    |
     --------|-------------------------------|
     Release |Terres. Animal  Drink   Aquatic|
     Radio-  |Plant   Product Water   Food   |
     nuclide |/kg     /kg     /L      /kg    |
     --------|------- ------- ------- -------|
```

EXHIBIT A.5. (contd)

```
TIME ##########################################################################

1     Intake ends after (yr)
50    Dose calc. ends after (yr)
1     Release ends after (yr)
0     No. of years of air deposition prior to the intake period
0     No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) #####################################

0           Definition option: 1-Use population grid in file POP.IN
0                              2-Use total entered on this line

NEAR-FIELD SCENARIOS #########################################################

            Prior to the beginning of the intake period: (yr)
0             When was the inventory disposed?  (Package degradation starts)
0             When was LOIC?  (Biotic transport starts)
0           Fraction of roots in upper soil (top 15 cm)
0           Fraction of roots in deep soil
0           Manual redistribution: deep soil/surface soil dilution factor

TRANSPORT ####################################################################
            ====AIR TRANSPORT====================================SECTION 1=====
                    0-Calculate PM            |
 1          Option: 1-Use chi/Q or PM value   |F           Stack release (T/F)
                    2-Select MI dist & dir    |0           Stack height (m)
                    3-Specifc MI dist & dir   |0           Stack flow (m3/sec
0           Chi/Q or PM value                 |0           Stack radius (m)
0           MI sector index (1=S)             |0           Effluent temp. (C)
0           MI distance from release point (m)
T           Use joint frequency data, otherwise chi/Q grid

            ====SURFACE WATER TRANSPORT==========================SECTION 2=====
 0          Mixing ratio model: 0-use value, 1-river, 2-lake, 3-river flow
1.0         Mixing ratio, dimensionless
2860.0      Average river flow rate for: MIXFLG=0,3 (m3/s), MIXFLG=1,2 (m/s),
24.0        Transit time to irrigation withdrawl location (hr)
            If mixing ratio model > 0:
0.0           Rate of effluent discharge to receiving water body (m3/s)
0.0           Longshore distance from release point to usage location (m)
0.0           Offshore distance to the water intake (m)
0.0           Average water depth in surface water body (m)
0             Average river width (m), MIXFLG=1 only
0             Depth of effluent discharge point to surface water (m), lake only

            ====WASTE FORM AVAILABILITY==========================SECTION 3=====
0           Waste form/package half life, (yr)
0           Waste thickness, (m)
0           Depth of soil overburden, m
```

EXHIBIT A.5. (contd)

```
               ====BIOTIC TRANSPORT OF BURIED SOURCE================SECTION 4=====
T              Consider during inventory decay/build-up period (T/F)?
T              Consider during intake period (T/F)?    | 1-Arid non agricultural
0              Pre-Intake site condition.............| 2-Humid non agricultural
                                                       | 3-Agricultural

EXPOSURE ####################################################################

               ====EXTERNAL EXPOSURE================================SECTION 5=====
               Exposure time:                 |  Residential irrigation:
0                Plume (hr)                   | T      Consider: (T/F)
4380.0           Soil contamination (hr)      | 2        Source: 1-ground water
100.0            Swimming (hr)                |                  2-surface water
100.0            Boating (hr)                 | 40.0     Application rate (in/yr)
500.0            Shoreline activities (hr)    | 6        Duration (mo/yr)
1              Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
8              Transit time for release to reach aquatic recreation (hr)
0              Average fraction of time submersed in acute cloud (hr/person-hr)

               ====INHALATION=======================================SECTION 6=====
0              Hours of exposure to contamination per year
0              0-No resus-  1-Use Mass Loading          2-Use Anspaugh model
0                pension      Mass loading factor (g/m3)   Top soil available (cm)

               ====INGESTION POPULATION=============================SECTION 7=====
0              Atmospheric production definition (select option):
0                0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line
                 1-Use population-weighted chi/Q
                 2-Use uniform production
                 3-Use chi/Q and production grids (PRODUCTION will be overridden)
0              Population ingesting aquatic foods, 0 defaults to total (person)
0              Population ingesting drinking water, 0 defaults to total (person)
F              Consider dose from food exported out of region (default=F)

               Note below: S* or Source: 0-none, 1-ground water, 2-surface water
                                         3-drinking water system
               ==== AQUATIC FOODS / DRINKING WATER INGESTION=========SECTION 8====

F              Salt water? (default is fresh)

               USE        TRAN-  PROD-     -CONSUMPTION-  |
               ?   FOOD   SIT    UCTION    HOLDUP   RATE  |
               T/F TYPE   hr     kg/yr     da      kg/yr  |     DRINKING WATER
               --- ------ -----  -------   ------  -----  | -----------------------
               T   FISH   0.00   1.5E+04    1.00    40.0  | 2      Source (see above)
               F   MOLLUS 0.00   0.0E+00    0.00     0.0  | T      Treatment? T/F
               F   CRUSTA 0.00   0.0E+00    0.00     0.0  | 1      Holdup/transit(da)
               F   PLANTS 0.00   0.0E+00    0.00     0.0  | 730    Consumption (L/yr)
```

EXHIBIT A.5. (contd)

====TERRESTRIAL FOOD INGESTION======================SECTION 9=====

USE ? T/F	FOOD TYPE	GROW TIME da	--IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m2	PROD-UCTION kg/yr	--CONSUMPTION-- HOLDUP da	RATE kg/yr
T	LEAF V	90.00	2	35.0	6.0	1.5	0.0E+00	1.0	30.0
T	ROOT V	90.00	2	40.0	6.0	4.0	0.0E+00	5.0	220.0
T	FRUIT	90.00	2	35.0	6.0	2.0	0.0E+00	5.0	330.0
T	GRAIN	90.00	2	0.0	0.0	0.8	0.0E+00	180.0	80.0

====ANIMAL PRODUCTION CONSUMPTION===================SECTION 10====

USE ? T/F	FOOD TYPE	---HUMAN---- CONSUMPTION RATE kg/yr	HOLDUP da	TOTAL PROD-UCTION kg/yr	DRINK WATER CONTAM FRACT.	-----STORED FEED----- DIET FRAC-TION	GROW TIME da	-IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m3	STOR-AGE da
T	BEEF	80.0	15.0	0.00	1.00	0.25	90.0	2	0.0	0.00	0.80	180.0
T	POULTR	18.0	1.0	0.00	1.00	1.00	90.0	2	0.0	0.00	0.80	180.0
T	MILK	270.0	1.0	0.00	1.00	0.25	45.0	2	47.0	6.00	2.00	100.0
T	EGG	30.0	1.0	0.00	1.00	1.00	90.0	2	0.0	0.00	0.80	180.0
						------FRESH FORAGE------						
	BEEF					0.75	45.0	2	47.0	6.00	2.00	100.0
	MILK					0.75	30.0	2	47.0	6.00	1.50	0.0

##

EXHIBIT A.6. GENII Output File - Sample Problem 2

```
------------------------------------------------------------------------------
                         GENII  Dose Calculation Program
                            (Version 1.351 30-Aug-88)

Case title:   GENII Sample Problem 2

Executed on:  09/27/88 at 17:07:30                                 Page A.  1
------------------------------------------------------------------------------

          This is a far-field (wide-scale release, multiple site) scenario.
          Release is chronic
          Individual dose

          THE FOLLOWING TRANSPORT MODES ARE CONSIDERED
               Surface Water

          THE FOLLOWING EXPOSURE PATHS ARE CONSIDERED:
               Ground, external
               Recreation, external
               Drinking water ingestion
               Aquatic foods ingestion
               Terrestrial foods ingestion
               Animal product ingestion

          THE FOLLOWING TIMES ARE USED:
               Intake ends after (yr):                1.0
               Dose calculations ends after (yr):    50.0
               Release ends after (yr):               1.0

========== FILE NAMES AND TITLES OF FILES/LIBRARIES USED =====================

                                         \genii\sam\sample2.in            8-05-88
GENII Default Parameter Values (3-Aug-88 RAP)                             8-12-88
RMDLIB - Radionuclide Master Library  (29-Aug-88 RAP)                     8-29-88
Food Transfer Factor Library - (RAP  29-Aug-88) (UPDATED LEACHING FA      8-29-88
Bioaccumulation Factor Library - (30-Aug-88) RAP                          8-30-88
External Dose Factors for GENII in person-Sv/yr per Bq/n (28-Aug-88       8-29-88
Internal Yearly Dose Increments  (Sv/Bq)  29-Aug-88  RAP                  8-29-88

==============================================================================

          -------- ----Release Terms------
          Release          Surface Buried
          Radio-   Air     Water   Source
          nuclide  Ci/yr   Ci/yr   Ci/m3
          -------- ------- ------- -------
          H 3      0.0E+00 5.3E+03 0.0E+00
          I 129    0.0E+00 9.0E-03 0.0E+00
```

EXHIBIT A.6. (contd)

```
========== SURFACE WATER TRANSPORT ============================================
       0   Mixing ratio model:  0-use value, 1-river, 2-lake, 3-river flow
 2.4E+01   Transit time to irrigation withdrawl location (h)
 2.9E+03   Average water flow rate for: MIXFLG=1,2 (m/s), MIXFLG=0,3 (m3/s)
 1.0E+00   Mixing ratio, dimensionless

========== EXTERNAL EXPOSURE ==================================================
 4.4E+03   Hours of exposure to ground contamination
       2   Residential irrigation source 1-ground water, 2-surface water
 4.0E+01   Residential irrigation application rate (in/yr)
 6.0E+00   Residential irrigation duration (mo/yr)
 1.0E+02   Hours of exposure from swimming
 1.0E+02   Hours of exposure from boating
 5.0E+02   Hours of exposure from shoreline activities
       1   Shoreline type: 1-river, 2-lake, 3-ocean, 4-tidal basin
 8.0E+00   Surface water transit time to recreational site (h)

========== DRINKING WATER SOURCE/IRRIGATION ===================================
 7.3E+02   Drinking water consumption rate (l/yr)
       2   Drinking water source: 1-ground, 2-surface,  3-system
       T   Drinking water treatment: T/F
     1.0   Drinking water transit/holdup time (d)

========== AQUATIC FOODS INGESTION ============================================

                    TRAN-     PROD-     ----CONSUMPTION----
           FOOD     SIT       UCTION    HOLDUP    RATE
           TYPE     h          kg/yr    d         kg/yr
           -------- --------- --------- --------- ---------
           Fish      0.00E+00  1.50E+04  1.00E+00  4.00E+01

========== TERRESTRIAL FOOD INGESTION =========================================

                    GROW    --IRRIGATION--          PROD-    --CONSUMPTION--
           FOOD     TIME    S RATE   TIME    YIELD  UCTION   HOLDUP    RATE
           TYPE     d       * in/yr  mo/yr   kg/m2  kg/yr    d         kg/yr
           -------- -----   - -----  -----   -----  -------  ------   ------
           Leaf Veg  90.0   2  35.0    6.0     1.5  0.00E+00    1.0  3.0E+01
           Oth. Veg  90.0   2  40.0    6.0     4.0  0.00E+00    5.0  2.2E+02
           Fruit     90.0   2  35.0    6.0     2.0  0.00E+00    5.0  3.3E+02
           Cereals   90.0   2   0.0    0.0     0.8  0.00E+00  180.0  8.0E+01
```

EXHIBIT A.6. (contd)

========== ANIMAL FOOD INGESTION ==========

FOOD TYPE	HUMAN CONSUMPTION RATE kg/yr	HUMAN HOLDUP d	TOTAL PRODUCTION kg/yr	DRINK WATER CONTAM FRACT.	DIET FRACTION	GROW TIME d	S *	IRRIGATION RATE in/yr	IRRIGATION TIME mo/yr	YIELD kg/m3	STORAGE d
					STORED FEED						
Meat	8.0E+01	15.0	0.0E+00	1.00	0.3	90.00	2	0.0	0.0	0.80	180.0
Poultry	1.8E+01	1.0	0.0E+00	1.00	1.0	90.00	2	0.0	0.0	0.80	180.0
Cow Milk	2.7E+02	1.0	0.0E+00	1.00	0.3	45.00	2	47.0	6.0	2.00	100.0
Eggs	3.0E+01	1.0	0.0E+00	1.00	1.0	90.00	2	0.0	0.0	0.80	180.0
					FRESH FORAGE						
Meat					0.75	45.0	2	47.0	6.0	2.00	100.0
Cow Milk					0.75	30.0	2	47.0	6.0	1.50	0.0

Input prepared by: ______________________ Date: __________

Input checked by: ______________________ Date: __________

Source area external dose modification factor: 1.00000

EXHIBIT A.6. (contd)

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 2

Executed on: 09/27/88 at 17:08:32 Page C. 3

Release period:	1.0
Uptake/exposure period:	1.0
Dose commitment period:	50.0
Dose units:	Rem

Committed Dose Equivalent by Exposure Pathway

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Leaf Veg	6.9E-08	4.0E-08	7.3E-08	7.3E-08	7.3E-08	3.4E-08	6.9E-08	6.9E-08
Oth. Veg	5.0E-07	2.9E-07	5.3E-07	5.3E-07	5.3E-07	2.4E-07	5.0E-07	5.0E-07
Fruit	1.1E-06	6.5E-07	1.2E-06	1.2E-06	1.2E-06	5.5E-07	1.1E-06	1.1E-06
Cereals	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Meat	2.5E-07	1.5E-07	2.7E-07	2.7E-07	2.7E-07	1.2E-07	2.5E-07	2.5E-07
Poultry	5.0E-08	2.9E-08	5.3E-08	5.3E-08	5.3E-08	2.4E-08	5.0E-08	5.0E-08
Cow Milk	9.4E-07	5.4E-07	1.0E-06	1.0E-06	1.0E-06	4.6E-07	9.4E-07	9.4E-07
Eggs	8.8E-08	5.1E-08	9.3E-08	9.3E-08	9.3E-08	4.3E-08	8.8E-08	8.8E-08
Swim Ing	7.5E-09	4.4E-09	8.0E-09	8.0E-09	8.0E-09	3.7E-09	7.5E-09	7.5E-09
Water	2.7E-06	1.6E-06	2.9E-06	2.9E-06	2.9E-06	1.3E-06	2.7E-06	2.7E-06
Fish	1.4E-07	8.4E-08	1.5E-07	1.5E-07	1.5E-07	7.1E-08	1.5E-07	1.4E-07
Total	5.9E-06	3.4E-06	6.2E-06	6.2E-06	6.2E-06	2.9E-06	5.9E-06	5.9E-06

EXHIBIT A.6. (contd)

Pathway	Ovaries	Muscle	Thyroid	Bladder
Leaf Veg	6.9E-08	6.9E-08	3.8E-07	5.1E-11
Oth. Veg	5.0E-07	5.0E-07	8.0E-07	5.1E-11
Fruit	1.1E-06	1.1E-06	1.4E-06	4.5E-11
Cereals	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Meat	2.5E-07	2.5E-07	4.6E-07	3.4E-11
Poultry	5.0E-08	5.0E-08	5.0E-08	1.3E-14
Cow Milk	9.4E-07	9.4E-07	3.1E-06	3.6E-10
Eggs	8.8E-08	8.8E-08	1.1E-07	3.4E-12
Swim Ing	7.5E-09	7.5E-09	9.2E-09	2.7E-13
Water	2.7E-06	2.7E-06	3.2E-06	7.9E-11
Fish	1.4E-07	1.4E-07	1.8E-06	2.7E-10
Total	5.9E-06	5.9E-06	1.1E-05	8.9E-10

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 2

Executed on: 09/27/88 at 17:08:32 Page C. 4

Release period:	1.0
Uptake/exposure period:	1.0
Dose commitment period:	50.0
Dose units:	Rem

External Dose by Exposure Pathway

Pathway	
Sur Soil	1.4E-12
Swim Ext	1.8E-13
Boating	9.2E-14
Shore	1.2E-12
Total	2.9E-12

EXHIBIT A.6. (contd)

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 2

Executed on: 09/27/88 at 17:08:32 Page C. 5

Release period:	1.0
Uptake/exposure period:	1.0
Dose commitment period:	50.0
Dose units:	Rem

Committed Dose Equivalent by Radionuclide

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
H 3	5.9E-06	3.4E-06	6.2E-06	6.2E-06	6.2E-06	2.9E-06	5.9E-06	5.9E-06
I 129	3.4E-10	3.9E-10	3.1E-10	2.9E-10	3.1E-10	2.7E-09	1.4E-09	2.7E-10
Total	5.9E-06	3.4E-06	6.2E-06	6.2E-06	6.2E-06	2.9E-06	5.9E-06	5.9E-06

Radionuclide	Ovaries	Muscle	Thyroid	Bladder
H 3	5.9E-06	5.9E-06	5.9E-06	0.0E+00
I 129	2.9E-10	6.8E-10	5.4E-06	8.9E-10
Total	5.9E-06	5.9E-06	1.1E-05	8.9E-10

Doses are calculated for exposure to radioactive materials deposited on the ground, on food crops, and on animal fodder. Because the code is working in a prospective mode, doses are calculated four times, that is assuming the release occurred in the winter, spring, summer, or autumn.

Because the population-weighted E/Q is input, neither the population data file nor the atmospheric dispersion data files are necessary. All the needed data is available in the input file. The data input file is presented in Exhibit A.7. The resultant output file is presented as Exhibit A.8.

The initial pages of output for Sample Problem 3 reflect the input. The page of atmospheric dispersion data, B.1, has been omitted from this document to save space, because it merely repeats the input E/Q value. The code produces extensive information about the exposures for each season. The format can be the same for each season as those shown for Sample Problems 1 and 2. For simplicity, only the effective dose equivalent summary pages for the four seasons are shown here. These are identified as pages C.1, C.4, C.7, and C.10 in Exhibit A.8. A detailed review of these outputs shows that the inhalation and submersion doses are the same for each season, as expected. However, the ingestion doses are smallest if an accident were to occur in winter when the agricultural productivity is lowest. Ingestion doses peak in autumn because, for that season, accidents are assumed to occur immediately before harvest.

The output data file MEDIA.OUT prepared by this example is given as Exhibit A.9. This file shows the integrated air, soil, and water concentrations calculated for each radionuclide for each season. The MEDIA.OUT file is not routinely printed, and must be accessed by the user <u>directly after</u> each GENII simulation.

A.4 GENII SAMPLE PROBLEM 4

The fourth sample problem displays the near-field scenario capabilities of the GENII package. In this scenario, an intruder is assumed to contact contaminated soil buried 5 meters below the ground through a drilling intrusion. The short exposure times and low manual redistribution factor are representative of someone inadvertently bringing a small amount of contaminated material to the soil surface and being exposed for a short time.

EXHIBIT A.7. GENII Input File - Sample Problem 3

```
######################### Program GENII Input File ############ 8 Mar 88 ####
Title: GENII Sample Problem 3
       \genii\sam\sample3.in                        Created on 08-05-1988 at 15:40
OPTIONS======================= Default ====================================
F    Near-field scenario?      (Far-field)    NEAR-FIELD: narrowly-focused
T    Population dose?         (Individual)                release, single site
T    Acute release?             (Chronic)     FAR-FIELD:  wide-scale release,
     Average Individual data set used                     multiple sites
                                Complete                                 Complete
TRANSPORT OPTIONS============   Section    EXPOSURE PATHWAY OPTIONS=====  Section
T  Air Transport                   1        F  Finite plume, external       5
F  Surface Water Transport         2        T  Infinite plume, external     5
F  Biotic Transport (near-field)   3        T  Ground, external             5
F  Waste Form Degradation (near)   4        F  Recreation, external         5
                                            T  Inhalation uptake            6
REPORT OPTIONS=====================         F  Drinking water ingestion     7,8
T  Report AEDE only                         F  Aquatic foods ingestion      7,8
F  Report by radionuclide                   T  Terrestrial foods ingestion  7,9
F  Report by exposure pathway               T  Animal product ingestion     7,10
F  Debug report on screen                   F  Inadvertent soil ingestion

INVENTORY ##################################################################

 4   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 0   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

     --------|----Release Terms------|----------Basic Concentrations---------|
     Use when|  transport selected   |  near-field scenario, optionally      |
     --------|-----------------------|---------------------------------------|
     Release |        Surface Buried |        Surface Deep    Ground  Surface|
     Radio-  |Air     Water   Waste  |Air     Soil    Soil    Water   Water  |
     nuclide |/yr     /yr     /m3    |/L      /unit   /m3     /L      /L     |
     --------|------- ------- -------|------- ------- ------- ------- -------|
     SM153    2.8E-4
     EU154    6.8E-6
     EU155    7.0E-6
     EU156    7.8E-4
     CO60     1.2E-6
     CR51     2.9E-6
     FE59     2.5E-6
     FE55     3.0E-5

     --------|----Derived Concentrations-----|
     Use when|  measured values are known    |
     --------|-------------------------------|
     Release |Terres. Animal  Drink   Aquatic|
     Radio-  |Plant   Product Water   Food   |
     nuclide |/kg     /kg     /L      /kg    |
     --------|------- ------- ------- -------|
```

EXHIBIT A.7. (contd)

```
TIME ##########################################################################

1     Intake ends after (yr)
50    Dose calc. ends after (yr)
0     Release ends after (yr)
0     No. of years of air deposition prior to the intake period
0     No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) ######################################

2           Definition option: 1-Use population grid in file POP.IN
1                              2-Use total entered on this line

NEAR-FIELD SCENARIOS ##########################################################

            Prior to the beginning of the intake period: (yr)
0             When was the inventory disposed?  (Package degradation starts)
0             When was LOIC?  (Biotic transport starts)
0           Fraction of roots in upper soil (top 15 cm)
0           Fraction of roots in deep soil
0           Manual redistribution: deep soil/surface soil dilution factor

TRANSPORT #####################################################################
            ====AIR TRANSPORT=====================================SECTION 1=====
                    0-Calculate PM          |
1           Option: 1-Use chi/Q or PM value |F          Stack release (T/F)
                    2-Select MI dist & dir  |0          Stack height (m)
                    3-Specify MI dist & dir |0          Stack flow (m3/sec
6.8E-3      Chi/Q or PM value               |0          Stack radius (m)
0           MI sector index (1=S)           |0          Effluent temp. (C)
0           MI distance from release point (m)
F           Use joint frequency data, otherwise chi/Q grid

            ====SURFACE WATER TRANSPORT===========================SECTION 2=====
0           Mixing ratio model: 0-use value, 1-river, 2-lake, 3-river flow
0           Mixing ratio, dimensionless
0           Average river flow rate for: MIXFLG=0,3 (m3/s), MIXFLG=1,2 (m/s),
0           Transit time to irrigation withdrawl location (hr)
            If mixing ratio model > 0:
0             Rate of effluent discharge to receiving water body (m3/s)
0             Longshore distance from release point to usage location (m)
0             Offshore distance to the water intake (m)
0             Average water depth in surface water body (m)
0             Average river width (m), MIXFLG=1 only
0             Depth of effluent discharge point to surface water (m), lake only

            ====WASTE FORM AVAILABILITY===========================SECTION 3=====
0           Waste form/package half life, (yr)
0           Waste thickness, (m)
0           Depth of soil overburden, m
```

EXHIBIT A.7. (contd)

```
          ====BIOTIC TRANSPORT OF BURIED SOURCE================SECTION 4=====
T         Consider during inventory decay/build-up period (T/F)?
T         Consider during intake period (T/F)?   | 1-Arid non agricultural
0         Pre-Intake site condition..............| 2-Humid non agricultural
                                                 | 3-Agricultural

EXPOSURE ###################################################################

          ====EXTERNAL EXPOSURE================================SECTION 5=====
          Exposure time:                  |   Residential irrigation:
0           Plume (hr)                    | T        Consider: (T/F)
2920.0      Soil contamination (hr)       | 0        Source: 1-ground water
0           Swimming (hr)                 |                  2-surface water
0           Boating (hr)                  | 0        Application rate (in/yr)
0           Shoreline activities (hr)     | 0        Duration (mo/yr)
0         Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
0         Transit time for release to reach aquatic recreation (hr)
1.0       Average fraction of time submersed in acute cloud (hr/person-hr)

          ====INHALATION=======================================SECTION 6=====
2920.0    Hours of exposure to contamination per year
0         0-No resus-  1-Use Mass Loading          2-Use Anspaugh model
0           pension      Mass loading factor (g/m3)   Top soil available (cm)

          ====INGESTION POPULATION=============================SECTION 7=====
 1        Atmospheric production definition (select option):
0           0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line
            1-Use population-weighted chi/Q
            2-Use uniform production
            3-Use chi/Q and production grids (PRODUCTION will be overridden)
0         Population ingesting aquatic foods, 0 defaults to total (person)
0         Population ingesting drinking water, 0 defaults to total (person)
F         Consider dose from food exported out of region (default=F)

          Note below: S* or Source: 0-none, 1-ground water, 2-surface water
                                    3-Derived concentration entered above
          ==== AQUATIC FOODS / DRINKING WATER INGESTION=========SECTION 8====

F         Salt water? (default is fresh)

          USE         TRAN-  PROD-      -CONSUMPTION-   |
          ?   FOOD    SIT    UCTION     HOLDUP   RATE   |
          T/F TYPE    hr     kg/yr      da       kg/yr  |        DRINKING WATER
          --- ------  -----  -------    ------   -----  |------------------------
          F   FISH    0.00   0.0E+00     0.00     0.0   | 0        Source (see above)
          F   MOLLUS  0.00   0.0E+00     0.00     0.0   | T        Treatment? T/F
          F   CRUSTA  0.00   0.0E+00     0.00     0.0   | 0        Holdup/transit(da)
          F   PLANTS  0.00   0.0E+00     0.00     0.0   | 0        Consumption (L/yr)
```

EXHIBIT A.7. (contd)

====TERRESTRIAL FOOD INGESTION=======================SECTION 9=====

USE ? T/F	FOOD TYPE	GROW TIME da	--IRRIGATION-- S *	--IRRIGATION-- RATE in/yr	--IRRIGATION-- TIME mo/yr	YIELD kg/m2	PROD-UCTION kg/yr	--CONSUMPTION-- HOLDUP da	--CONSUMPTION-- RATE kg/yr
T	LEAF V	90.00	0	0.0	0.0	1.5	0.0E+00	14.0	15.0
T	ROOT V	90.00	0	0.0	0.0	4.0	0.0E+00	14.0	140.0
T	FRUIT	90.00	0	0.0	0.0	2.0	0.0E+00	14.0	64.0
T	GRAIN	90.00	0	0.0	0.0	0.8	0.0E+00	180.0	72.0

====ANIMAL PRODUCTION CONSUMPTION===================SECTION 10====

USE ? T/F	FOOD TYPE	---HUMAN---- CONSUMPTION RATE kg/yr	---HUMAN---- CONSUMPTION HOLDUP da	TOTAL PROD-UCTION kg/yr	DRINK WATER CONTAM FRACT.	--STORED FEED-- DIET FRAC-TION	GROW TIME da	-IRRIGATION-- S *	-IRRIGATION-- RATE in/yr	-IRRIGATION-- TIME mo/yr	YIELD kg/m3	STOR-AGE da
T	BEEF	70.0	34.0	0.00	0.00	0.00	90.0	0	0.0	0.00	0.80	0.0
T	POULTR	8.5	34.0	0.00	0.00	0.00	90.0	0	0.0	0.00	0.80	0.0
T	MILK	230.0	4.0	0.00	0.00	0.00	45.0	0	0.0	0.00	2.00	0.0
T	EGG	20.0	18.0	0.00	0.00	0.00	90.0	0	0.0	0.00	0.80	0.0
						--FRESH FORAGE--						
	BEEF					0.00	45.0	0	0.0	0.00	2.00	100.0
	MILK					0.00	30.0	0	0.0	0.00	1.50	0.0

##

EXHIBIT A.8. GENII Output File - Sample Problem 3

```
------------------------------------------------------------------------------
                    GENII  Dose Calculation Program
                     (Version 1.351 30-Aug-88)

Case title:   GENII Sample Problem 3

Executed on:  09/28/88 at 14:36:46                                Page A.  1
------------------------------------------------------------------------------

          This is a far-field (wide-scale release, multiple site) scenario.
          Release is acute
          Dose to exposed population of  1.000E+00

          THE FOLLOWING TRANSPORT MODES ARE CONSIDERED
               Air

          THE FOLLOWING EXPOSURE PATHS ARE CONSIDERED:
               Infinite plume, external
               Ground, external
               Inhalation uptake
               Terrestrial foods ingestion
               Animal product ingestion

          THE FOLLOWING TIMES ARE USED:
               Intake ends after (yr):                 1.0
               Dose calculations ends after (yr):     50.0

========== FILE NAMES AND TITLES OF FILES/LIBRARIES USED =====================

                                               \genii\sam\sample3.in        9-28-88
GENII Default Parameter Values (3-Aug-88 RAP)                              8-12-88
RMDLIB - Radionuclide Master Library  (29-Aug-88 RAP)                      8-29-88
Food Transfer Factor Library - (RAP  29-Aug-88) (UPDATED LEACHING FA       8-29-88
External Dose Factors for GENII in person-Sv/yr per Bq/n (28-Aug-88        8-29-88
Internal Yearly Dose Increments  (Sv/Bq)  29-Aug-88  RAP                   8-29-88

==============================================================================
```

Release Radio-nuclide	Air Ci/yr	Surface Water Ci/yr	Buried Source Ci/m3
SM153	2.8E-04	0.0E+00	0.0E+00
EU154	6.8E-06	0.0E+00	0.0E+00
EU155	7.0E-06	0.0E+00	0.0E+00
EU156	7.8E-04	0.0E+00	0.0E+00
CO60	1.2E-06	0.0E+00	0.0E+00
CR51	2.9E-06	0.0E+00	0.0E+00

EXHIBIT A.8. (contd)

FE59	2.5E-06	0.0E+00	0.0E+00
FE55	3.0E-05	0.0E+00	0.0E+00

========== AIR TRANSPORT ==========

6.8E-03 Input population-weighted E/Q value (s/m3)

========== EXTERNAL EXPOSURE ==========

1.0E+00 Fraction of time spent in cloud
2.9E+03 Hours of exposure to ground contamination

========== INHALATION ==========

2.9E+03 Hours of exposure to contamination per year
Resuspension not considered

========== INGESTION POPULATION ==========

1 Atmospheric production definition: 1 - Use population-weighted chi/Q
Food production in region assumed to equal consumption.

========== TERRESTRIAL FOOD INGESTION ==========

FOOD TYPE	GROW TIME d	--IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m2	PROD-UCTION kg/yr	--CONSUMPTION-- HOLDUP d	RATE kg/yr
Leaf Veg	90.0	0	0.0	0.0	1.5		14.0	1.5E+01
Oth. Veg	90.0	0	0.0	0.0	4.0		14.0	1.4E+02
Fruit	90.0	0	0.0	0.0	2.0		14.0	6.4E+01
Cereals	90.0	0	0.0	0.0	0.8		180.0	7.2E+01

========== ANIMAL FOOD INGESTION ==========

FOOD TYPE	---HUMAN---- CONSUMPTION RATE kg/yr	HOLDUP d	TOTAL PROD-UCTION kg/yr	DRINK WATER CONTAM FRACT.	DIET FRAC-TION	----STORED FEED---- GROW TIME d	-IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m3	STOR-AGE d
Meat	7.0E+01	34.0		0.00		90.00	0	0.0	0.0	0.80	0.0
Poultry	8.5E+00	34.0		0.00		90.00	0	0.0	0.0	0.80	0.0
Cow Milk	2.3E+02	4.0		0.00		45.00	0	0.0	0.0	2.00	0.0
Eggs	2.0E+01	18.0		0.00		90.00	0	0.0	0.0	0.80	0.0
						----FRESH FORAGE----					
Meat						45.00	0	0.0	0.0	2.00	0.0
Cow Milk						30.00	0	0.0	0.0	1.50	0.0

==========

EXHIBIT A.8. (contd)

Input prepared by: ______________________________ Date: ______________

Input checked by: ______________________________ Date: ______________

==

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: Winter: GENII Sample Problem 3

Executed on: 09/28/88 at 14:39:30 Page C. 1

Acute release	
Uptake/exposure period:	1.0
Dose commitment period:	50.0
Dose units:	Person-rem

Organ	Committed Dose Equivalent	Weighting Factors	Weighted Dose Equivalent
Gonads	5.0E-06	2.5E-01	1.2E-06
Breast	3.7E-06	1.5E-01	5.5E-07
R Marrow	1.5E-05	1.2E-01	1.8E-06
Lung	1.4E-04	1.2E-01	1.7E-05
Thyroid	2.1E-06	3.0E-02	6.4E-08
Bone Sur	5.7E-05	3.0E-02	1.7E-06
LL Int.	7.3E-05	6.0E-02	4.4E-06
Liver	5.2E-05	6.0E-02	3.1E-06
UL Int.	2.9E-05	6.0E-02	1.7E-06
Kidneys	1.1E-05	6.0E-02	6.4E-07
S Int.	9.7E-06	6.0E-02	5.8E-07
Internal Effective Dose Equivalent			3.3E-05
External Dose			5.8E-06
Annual Effective Dose Equivalent			3.9E-05

Controlling Organ:	Lung
Controlling Pathway:	Inh
Controlling Radionuclide:	EU156
Inhalation EDE:	3.3E-05
Ingestion EDE:	7.3E-09

EXHIBIT A.8. (contd)

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: Spring: GENII Sample Problem 3

Executed on: 09/28/88 at 14:40:32 Page C. 4

Acute release
Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Person-rem

Organ	Committed Dose Equivalent	Weighting Factors	Weighted Dose Equivalent
Gonads	8.3E-06	2.5E-01	2.1E-06
Breast	4.3E-06	1.5E-01	6.4E-07
R Marrow	1.6E-05	1.2E-01	1.9E-06
Lung	1.4E-04	1.2E-01	1.7E-05
Thyroid	2.4E-06	3.0E-02	7.2E-08
Bone Sur	5.8E-05	3.0E-02	1.7E-06
LL Int.	1.3E-04	6.0E-02	7.7E-06
Liver	5.4E-05	6.0E-02	3.2E-06
UL Int.	5.0E-05	6.0E-02	3.0E-06
S Int.	1.6E-05	6.0E-02	9.5E-07
Kidneys	1.1E-05	6.0E-02	6.6E-07
Internal Effective Dose Equivalent			3.9E-05
External Dose			5.8E-06
Annual Effective Dose Equivalent			4.5E-05

Controlling Organ: Lung
Controlling Pathway: Inh
Controlling Radionuclide: EU156

Inhalation EDE: 3.3E-05
Ingestion EDE: 6.3E-06

EXHIBIT A.8. (contd)

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: Summer: GENII Sample Problem 3

Executed on: 09/28/88 at 14:41:32 Page C. 7

Acute release	
Uptake/exposure period:	1.0
Dose commitment period:	50.0
Dose units:	Person-rem

Organ	Committed Dose Equivalent	Weighting Factors	Weighted Dose Equivalent
Gonads	1.0E-05	2.5E-01	2.5E-06
Breast	4.8E-06	1.5E-01	7.1E-07
R Marrow	1.7E-05	1.2E-01	2.0E-06
Lung	1.4E-04	1.2E-01	1.7E-05
Thyroid	2.7E-06	3.0E-02	8.2E-08
Bone Sur	6.1E-05	3.0E-02	1.8E-06
LL Int.	1.5E-04	6.0E-02	9.2E-06
UL Int.	5.9E-05	6.0E-02	3.5E-06
Liver	5.7E-05	6.0E-02	3.4E-06
S Int.	1.9E-05	6.0E-02	1.1E-06
Kidneys	1.1E-05	6.0E-02	6.8E-07
Internal Effective Dose Equivalent			4.2E-05
External Dose			5.8E-06
Annual Effective Dose Equivalent			4.8E-05

Controlling Organ:	LL Int.
Controlling Pathway:	Inh
Controlling Radionuclide:	EU156
Inhalation EDE:	3.3E-05
Ingestion EDE:	9.5E-06

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: Autumn: GENII Sample Problem 3

Executed on: 09/28/88 at 14:42:32 Page C. 10

Acute release
Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Person-rem

Organ	Committed Dose Equivalent	Weighting Factors	Weighted Dose Equivalent
Gonads	3.0E-05	2.5E-01	7.6E-06
Breast	1.1E-05	1.5E-01	1.6E-06
R Marrow	2.7E-05	1.2E-01	3.2E-06
Lung	1.5E-04	1.2E-01	1.8E-05
Thyroid	7.1E-06	3.0E-02	2.1E-07
Bone Sur	8.3E-05	3.0E-02	2.5E-06
LL Int.	4.0E-04	6.0E-02	2.4E-05
UL Int.	1.5E-04	6.0E-02	9.3E-06
Liver	8.4E-05	6.0E-02	5.0E-06
S Int.	5.0E-05	6.0E-02	3.0E-06
Stomach	2.3E-05	6.0E-02	1.4E-06
Internal Effective Dose Equivalent			7.6E-05
External Dose			5.8E-06
Annual Effective Dose Equivalent			8.1E-05

Controlling Organ:	LL Int.•
Controlling Pathway:	Ing
Controlling Radionuclide:	EU156
Inhalation EDE:	3.3E-05
Ingestion EDE:	4.3E-05

EXHIBIT A.9. GENII MEDIA.OUT Putput File Sample Problem 3

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem Three

Executed on: 09/28/88 at 14:37:35 Page 2

		------Residential------		
Radio-nuclide	Season or Year	Average Population-Weighted Air Ci sec/m3	Surface Soil Ci/m2	Time Integrated Surface Water Ci yr/L
CR51	Winter	2.0E-08	2.2E-12	0.0E+00
CR51	Spring	2.0E-08	2.2E-12	0.0E+00
CR51	Summer	2.0E-08	2.2E-12	0.0E+00
CR51	Autumn	2.0E-08	2.2E-12	0.0E+00
FE55	Winter	2.0E-07	1.8E-10	0.0E+00
FE55	Spring	2.0E-07	1.8E-10	0.0E+00
FE55	Summer	2.0E-07	1.8E-10	0.0E+00
FE55	Autumn	2.0E-07	1.8E-10	0.0E+00
FE59	Winter	1.7E-08	3.0E-12	0.0E+00
FE59	Spring	1.7E-08	3.0E-12	0.0E+00
FE59	Summer	1.7E-08	3.0E-12	0.0E+00
FE59	Autumn	1.7E-08	3.0E-12	0.0E+00
CO60	Winter	8.2E-09	7.6E-12	0.0E+00
CO60	Spring	8.2E-09	7.6E-12	0.0E+00
CO60	Summer	8.2E-09	7.6E-12	0.0E+00
CO60	Autumn	8.2E-09	7.6E-12	0.0E+00
SM153	Winter	1.9E-06	1.5E-11	0.0E+00
SM153	Spring	1.9E-06	1.5E-11	0.0E+00
SM153	Summer	1.9E-06	1.5E-11	0.0E+00
SM153	Autumn	1.9E-06	1.5E-11	0.0E+00
EU154	Winter	4.6E-08	4.4E-11	0.0E+00
EU154	Spring	4.6E-08	4.4E-11	0.0E+00
EU154	Summer	4.6E-08	4.4E-11	0.0E+00
EU154	Autumn	4.6E-08	4.4E-11	0.0E+00
EU155	Winter	4.8E-08	4.4E-11	0.0E+00
EU155	Spring	4.8E-08	4.4E-11	0.0E+00
EU155	Summer	4.8E-08	4.4E-11	0.0E+00
EU155	Autumn	4.8E-08	4.4E-11	0.0E+00
EU156	Winter	5.3E-06	3.2E-10	0.0E+00
EU156	Spring	5.3E-06	3.2E-10	0.0E+00
EU156	Summer	5.3E-06	3.2E-10	0.0E+00
EU156	Autumn	5.3E-06	3.2E-10	0.0E+00

Scenarios of this nature are frequently used in environmental impact statements involving waste disposal.

The input for this scenario is contained in the GENII input file. The input is shown in Exhibit A.10. The resulting output is presented in Exhibit A.11.

The initial pages define the scenario and repeat the input. No atmospheric dispersion calculations were performed, so no pages labeled B.n were produced. As for the other GENII samples, an effective dose equivalent summary page and a dose assembly matrix page were printed but omitted from this output to conserve space. Dose by exposure pathway is presented on page C.3 and dose by radionuclide on page C.4. The format of these pages is similar to that of the outputs of the other sample problems.

Note that for the scenario defined, no terrestrial food pathways or animal products were used. Therefore, no mention is made of these on the quality assurance pages.

A.5 INTDF SAMPLE PROBLEM

The INTDF code is used to prepare internal radiation dose factors for the other codes of the GENII package. Input is quite simple. The sample input file shown in Exhibit A.12 demonstrates the calculation of the 50-year dose commitments for the organs defined to be exposed from a single inhalation or ingestion intake of cobalt-60. Other radionuclides could be added to the calculation simply by appending them to the end of this file.

The output file resulting from the input of Exhibit A.12 is presented in Exhibit A.13. The first page of this file defines the input conditions and lists the metabolic data retrieved from the metabolic data library. If the DEBUG flag had been set TRUE in the input file, an additional set of pages displaying the specific effective energies (SEE) used in the dose calculation would have also been printed. The last page presents the total integrated retention (total number of disintegrations of cobalt-60 in each organ) and the calculated organ dose commitments. These numbers may be compared to those published by the ICRP in Publication 30 (ICRP 1979).

EXHIBIT A.10. GENII Input File -Sample Problem 4

```
######################### Program GENII Input File ########### 22 Apr 88 ####
Title: GENII Sample Problem 4
       \genii\sam\sample4.inN                   Created on 08-05-1988 at 16:03
OPTIONS======================== Default =====================================
T    Near-field scenario?       (Far-field)    NEAR-FIELD: narrowly-focused
F    Population dose?          (Individual)                release, single site
F    Acute release?              (Chronic)     FAR-FIELD:  wide-scale release,
     Maximum Individual data set used                      multiple sites
                                   Complete                                Complete
TRANSPORT OPTIONS============ Section     EXPOSURE PATHWAY OPTIONS===== Section
F  Air Transport                   1      F  Finite plume, external      5
F  Surface Water Transport         2      T  Infinite plume, external    5
F  Biotic Transport (near-field)  3,4     T  Ground, external            5
F  Waste Form Degradation (near)  3,4     F  Recreation, external        5
                                          T  Inhalation uptake           6
REPORT OPTIONS=======================     F  Drinking water ingestion    7,8
T  Report AEDE only                       F  Aquatic foods ingestion     7,8
F  Report by radionuclide                 F  Terrestrial foods ingestion 7,9
T  Report by exposure pathway             F  Animal product ingestion    7,10
F  Debug report on screen                 F  Inadvertent soil ingestion

INVENTORY ####################################################################

 1   Inventory input activity units: (1-pCi  2-uCi  3-mCi  4-Ci  5-Bq)
 1   Surface soil source units (1- m2  2- m3  3- kg)
     Equilibrium question goes here

     --------|----Release Terms------|----------Basic Concentrations---------|
     Use when| transport selected    | near-field scenario, optionally       |
     --------|-----------------------|---------------------------------------|
     Release |        Surface Buried |        Surface Deep    Ground  Surface|
     Radio-  |Air     Water   Waste  |Air     Soil    Soil    Water   Water  |
     nuclide |/yr     /yr     /m3    |/L      /unit   /m3     /L      /L     |
     --------|------- ------- -------|------- ------- ------- ------- -------|
     CO60                                             2.14E12
     NI59                                             9.29E10
     NI63                                             1.21E13
     SR90                                             2.14E09
     ZR93                                             7.86E10
     NB94                                             4.29E09
     MO93                                             1.43E09
     TC99                                             2.14E08
     EU152                                            1.43E10
     EU154                                            1.14E10
```

EXHIBIT A.10. (contd)

```
--------|----Derived Concentrations-----|
Use when|  measured values are known     |
--------|-------------------------------|
Release |Terres. Animal  Drink   Aquatic|
Radio-  |Plant   Product Water   Food   |
nuclide |/kg     /kg     /L      /kg    |
--------|------- ------- ------- -------|


TIME #########################################################################

1    Intake ends after (yr)
50   Dose calc. ends after (yr)
0    Release ends after (yr)
0    No. of years of air deposition prior to the intake period
0    No. of years of irrigation water deposition prior to the intake period

FAR-FIELD SCENARIOS (IF POPULATION DOSE) #####################################

0          Definition option: 1-Use population grid in file POP.IN
0                             2-Use total entered on this line

NEAR-FIELD SCENARIOS #########################################################

           Prior to the beginning of the intake period: (yr)
100.0        When was the inventory disposed?  (Package degradation starts)
0            When was LOIC?  (Biotic transport starts)
1.0        Fraction of roots in upper soil (top 15 cm)
0          Fraction of roots in deep soil
2.8E-3     Manual redistribution: deep soil/surface soil dilution factor
1000.0     Source area for external dose modification factor (m2)
TRANSPORT ####################################################################
           ====AIR TRANSPORT==================================SECTION 1=====
                   0-Calculate PM            |
 1         Option: 1-Use chi/Q or PM value   |F           Stack release (T/F)
                   2-Select MI dist & dir    |0           Stack height (m)
                   3-Specify MI dist & dir   |0           Stack flow (m3/sec
0          Chi/Q or PM value                 |0           Stack radius (m)
0          MI sector index (1=S)             |0           Effluent temp. (C)
0          MI distance from release point (m)
T          Use joint frequency data, otherwise chi/Q grid

           ====SURFACE WATER TRANSPORT========================SECTION 2=====
0          Mixing ratio model: 0-use value, 1-river, 2-lake
0          Mixing ratio, dimensionless
0          Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),
0          Transit time to irrigation withdrawl location (hr)
           If mixing ratio model > 0:
0            Rate of effluent discharge to receiving water body (m3/s)
0            Longshore distance from release point to usage location (m)
```

EXHIBIT A.10. (contd)

```
0            Offshore distance to the water intake (m)
0            Average water depth in surface water body (m)
0            Average river width (m), MIXFLG=1 only
0            Depth of effluent discharge point to surface water (m), lake only

           ====WASTE FORM AVAILABILITY==========================SECTION 3=====
0          Waste form/package half life, (yr)
10.0       Waste thickness, (m)
5.0        Depth of soil overburden, m

           ====BIOTIC TRANSPORT OF BURIED SOURCE================SECTION 4=====
T          Consider during inventory decay/build-up period (T/F)?
T          Consider during intake period (T/F)?  | 1-Arid non agricultural
0          Pre-Intake site condition.............| 2-Humid non agricultural
                                                 | 3-Agricultural

EXPOSURE ###################################################################

           ====EXTERNAL EXPOSURE================================SECTION 5=====
           Exposure time:                  |   Residential irrigation:
1.0          Plume (hr)                    | T       Consider: (T/F)
40.0         Soil contamination (hr)       | 0       Source: 1-ground water
0            Swimming (hr)                 |                 2-surface water
0            Boating (hr)                  | 0       Application rate (in/yr)
0            Shoreline activities (hr)     | 0       Duration (mo/yr)
0          Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)
0          Transit time for release to reach aquatic recreation (hr)
0          Average fraction of time submersed in acute cloud (hr/person-hr)

           ====INHALATION=======================================SECTION 6=====
1.0        Hours of exposure to contamination per year
1          0-No resus-  1-Use Mass Loading          2-Use Anspaugh model
.0001        pension      Mass loading factor (g/m3)   Top soil available (cm)

           ====INGESTION POPULATION=============================SECTION 7=====
0          Atmospheric production definition (select option):
0            0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line
             1-Use population-weighted chi/Q
             2-Use uniform production
             3-Use chi/Q and production grids (PRODUCTION will be overridden)
0          Population ingesting aquatic foods, 0 defaults to total (person)
0          Population ingesting drinking water, 0 defaults to total (person)
F          Consider dose from food exported out of region (default=F)

           Note below: S* or Source: 0-none, 1-ground water, 2-surface water
                                     3-Derived concentration entered above
           ==== AQUATIC FOODS / DRINKING WATER INGESTION=========SECTION 8====

F          Salt water? (default is fresh)
```

EXHIBIT A.10. (contd)

USE ? T/F	FOOD TYPE	TRAN-SIT hr	PROD-UCTION kg/yr	-CONSUMPTION- HOLDUP da	RATE kg/yr
F	FISH	0.00	0.0E+00	0.00	0.0
F	MOLLUS	0.00	0.0E+00	0.00	0.0
F	CRUSTA	0.00	0.0E+00	0.00	0.0
F	PLANTS	0.00	0.0E+00	0.00	0.0

DRINKING WATER	
0	Source (see above)
T	Treatment? T/F
0	Holdup/transit(da)
0	Consumption (L/yr)

====TERRESTRIAL FOOD INGESTION======================SECTION 9=====

USE ? T/F	FOOD TYPE	GROW TIME da	--IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m2	PROD-UCTION kg/yr	--CONSUMPTION-- HOLDUP da	RATE kg/yr
F	LEAF V	90.00	0	0.0	0.0	1.5	0.0E+00	1.0	30.0
F	ROOT V	90.00	0	0.0	0.0	4.0	0.0E+00	5.0	220.0
F	FRUIT	90.00	0	0.0	0.0	2.0	0.0E+00	5.0	330.0
F	GRAIN	90.00	0	0.0	0.0	0.8	0.0E+00	180.0	80.0

====ANIMAL PRODUCTION CONSUMPTION===================SECTION 10====

USE ? T/F	FOOD TYPE	---HUMAN---- CONSUMPTION RATE kg/yr	HOLDUP da	TOTAL PROD-UCTION kg/yr	DRINK WATER CONTAM FRACT.	-------------STORED FEED------------- DIET FRAC-TION	GROW TIME da	-IRRIGATION-- S *	RATE in/yr	TIME mo/yr	YIELD kg/m3	STOR-AGE da
F	BEEF	80.0	15.0	0.00	0.00	0.25	90.0	0	0.0	0.00	0.80	180.0
F	POULTR	18.0	1.0	0.00	0.00	1.00	90.0	0	0.0	0.00	0.80	180.0
F	MILK	270.0	1.0	0.00	0.00	0.25	45.0	0	0.0	0.00	2.00	100.0
F	EGG	30.0	1.0	0.00	0.00	1.00	90.0	0	0.0	0.00	0.80	180.0
						-------------FRESH FORAGE------------						
	BEEF					0.75	45.0	0	0.0	0.00	2.00	100.0
	MILK					0.75	30.0	0	0.0	0.00	1.50	0.0

##

EXHIBIT A.11. GENII Output File - Sample Problem 4

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 4

Executed on: 09/27/88 at 17:09:09 Page A. 1

This is a near field (narrowly-focused, single site) scenario.
Release is chronic
Individual dose

THE FOLLOWING EXPOSURE PATHS ARE CONSIDERED:
- Infinite plume, external
- Ground, external
- Inhalation uptake

THE FOLLOWING TIMES ARE USED:
- Intake ends after (yr): 1.0
- Dose calculations ends after (yr): 50.0

========== FILE NAMES AND TITLES OF FILES/LIBRARIES USED ==========

\genii\sam\sample4.inN	8-05-88
GENII Default Parameter Values (3-Aug-88 RAP)	8-12-88
RMDLIB - Radionuclide Master Library (29-Aug-88 RAP)	8-29-88
External Dose Factors for GENII in person-Sv/yr per Bq/n (28-Aug-88	8-29-88
Internal Yearly Dose Increments (Sv/Bq) 29-Aug-88 RAP	8-29-88

==========

1 Surface soil input unit: (1-m2, 2-m3, 3-kg)

	Basic Concentrations				
Release Radio- nuclide	Air pCi/L	Surface Soil pCi/m2	Deep Soil pCi/m3	Ground Water pCi/L	Surface Water pCi/L
CO60	0.0E+00	0.0E+00	2.1E+12	0.0E+00	0.0E+00
NI59	0.0E+00	0.0E+00	9.3E+10	0.0E+00	0.0E+00
NI63	0.0E+00	0.0E+00	1.2E+13	0.0E+00	0.0E+00
SR90	0.0E+00	0.0E+00	2.1E+09	0.0E+00	0.0E+00
ZR93	0.0E+00	0.0E+00	7.9E+10	0.0E+00	0.0E+00
NB94	0.0E+00	0.0E+00	4.3E+09	0.0E+00	0.0E+00
MO93	0.0E+00	0.0E+00	1.4E+09	0.0E+00	0.0E+00
TC99	0.0E+00	0.0E+00	2.1E+08	0.0E+00	0.0E+00
EU152	0.0E+00	0.0E+00	1.4E+10	0.0E+00	0.0E+00
EU154	0.0E+00	0.0E+00	1.1E+10	0.0E+00	0.0E+00

EXHIBIT A.11. (contd)

```
========== NEAR-FIELD PARAMETERS ===============================================
  100.0    Inventory disposed n years prior to beginning of intake period
      0    LOIC occurred n years prior to beginning of intake period
1.0E+00    Fraction of roots in upper soil (top 15 cm)
0.0E+00    Fraction of roots in deep soil
2.8E-03    Manual redistribution: deep soil/surface soil dilution factor
 1000.0    Source area for external dose modification factor (m2)

========== WASTE FORM AVAILABILITY =============================================
0.0E+00    Waste form/package half life, yr
1.0E+01    Thickness of buried waste, m
5.0E+00    Depth of soil overburden, m

========== EXTERNAL EXPOSURE ===================================================
 1.0E+00   Hours of exposure to plume
 4.0E+01   Hours of exposure to ground contamination

========== INHALATION ==========================================================
 1.0E+00   Hours of exposure to contamination per year
       1   Resuspension model:  1-Mass Loading, 2-Anspaugh
 1.0E-04   Mass loading factor (g/m3)

================================================================================
```

Input prepared by: ______________________________ . Date: _____________

Input checked by: ______________________________ Date: _____________

```
================================================================================
Source area external dose modification factor:    0.940000
```

EXHIBIT A.11. (contd)

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 4

Executed on: 09/27/88 at 17:11:20 Page C. 3

Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Committed Dose Equivalent by Exposure Pathway

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Inhale	1.1E-07	4.4E-09	4.3E-09	6.9E-09	1.5E-08	2.0E-07	2.2E-08	6.5E-09
Total	1.1E-07	4.4E-09	4.3E-09	6.9E-09	1.5E-08	2.0E-07	2.2E-08	6.5E-09

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver	Spleen	S Wall
Inhale	6.8E-09	6.9E-09	6.9E-09	3.7E-10	1.4E-10	7.4E-10	9.0E-13
Total	6.8E-09	6.9E-09	6.9E-09	3.7E-10	1.4E-10	7.4E-10	9.0E-13

External Dose by Exposure Pathway

Pathway	
Plume	0.0E+00
Sur Soil	1.9E-03
Dep Soil	1.7E-07
Total	1.9E-03

EXHIBIT A.11. (contd)

GENII Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 4

Executed on: 09/27/88 at 17:11:20 Page C. 4

Uptake/exposure period: 1.0
Dose commitment period: 50.0
Dose units: Rem

Radio-nuclide	Inhalation Effective Dose Equivalent	Ingestion Effective Dose Equivalent	External Dose	Internal Effective Dose Equivalent	Annual Effective Dose Equivalent
CO 60	9.2E-13	0.0E+00	2.6E-06	9.2E-13	2.6E-06
NI 59	8.9E-11	0.0E+00	1.1E-06	8.9E-11	1.1E-06
NI 63	1.4E-08	0.0E+00	1.0E-07	1.4E-08	1.1E-07
SR 90	4.5E-11	0.0E+00	5.8E-09	4.5E-11	5.8E-09
Y 90	1.9E-12	0.0E+00	3.2E-07	1.9E-12	3.2E-07
MO 93	7.4E-13	0.0E+00	1.4E-08	7.4E-13	1.4E-08
ZR 93	7.8E-09	0.0E+00	9.3E-10	7.8E-09	8.7E-09
NB 93M	2.9E-09	0.0E+00	3.7E-07	2.9E-09	3.7E-07
NB 94	2.0E-09	0.0E+00	1.8E-03	2.0E-09	1.8E-03
TC 99	1.0E-12	0.0E+00	4.1E-10	1.0E-12	4.1E-10
EU 152	2.1E-11	0.0E+00	2.8E-05	2.1E-11	2.8E-05
EU 154	1.4E-12	0.0E+00	1.4E-06	1.4E-12	1.4E-06

EXHIBIT A.12. GENII Input File - Problem 5

```
GENII Sample Problem 5 (INTDF)
50        'No. of years to consider
T         'Acute? if false then chronic
1.0       'Particle size, micron
F         'Print SEE's and Debug print statements?
1.0-6     'Relative error tolerance (LSODES2)
1.0-8     'Absolute error tolerance (LSODES2)
365.0     'Absolute step size allowed (LSODES2)
1.0-6     'Initial step size (LSODES2)
700       'Number of steps to reach convergence allowed (LSODES2)
F         10.0         'Fetal dose, age (da)
C060
```

EXHIBIT A.13. GENII Output File - Sample Problem 5

INTDF Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 5 (INTDF)
Executed on: 09/27/88 at 17:12:04 Page 1

---

1 CO60 V Y 1.92E+03 3.61E-04 0 0.00E+00 0 0.00E+00

General Model
Acute exposure

Dose commitment period: 50.0000

Particle size: 1.00000
Lung deposition fractions:
Nasal-pharynx region: 0.287834
Pulmonary region: 0.235379
Traecheo-bronchial region: 0.800000E-01

Integration method: LSODES2 equation solver
Relative error tolerance: 0.100000E-05
Absolute error tolerance: 0.100000E-07
Absolute step size allowed: 365.000
No. of steps to convergence allowed: 700
Starting time step: 0.100000E-05

Organ	Organ Index	Target?	Compartment Index	Organ Mass	ORGMLT	ORGING	ORGINH
Lung	1	T	18	1.0E+03	1.0E+00	1.5E-02	0.0E+00
Lymph	2	F	19	0.0E+00	1.0E+00	0.0E+00	0.0E+00
Stomach	3	T	20	2.5E+02	1.0E+00	0.0E+00	0.0E+00
S Int.	4	T	21	4.0E+02	1.0E+00	0.0E+00	0.0E+00
UL Int.	5	T	22	2.5E+02	1.0E+00	0.0E+00	0.0E+00
LL Int.	6	T	23	1.3E+02	1.0E+00	0.0E+00	0.0E+00
Bone Sur	7	T	24	0.0E+00	0.0E+00	0.0E+00	0.0E+00
R Marrow	8	T	24	1.5E+03	0.0E+00	2.2E-02	2.3E-02
Bone Cor	9	F	24	4.0E+03	8.0E-01	0.0E+00	0.0E+00
Bone Can	10	F	24	1.0E+03	2.0E-01	0.0E+00	0.0E+00
Testes	11	T	25	3.5E+01	0.0E+00	5.2E-04	5.3E-04
Ovaries	12	T	25	1.1E+01	0.0E+00	1.6E-04	1.7E-04
Muscle	13	T	25	2.8E+04	0.0E+00	4.2E-01	4.2E-01
Thyroid	14	T	25	2.0E+01	0.0E+00	3.0E-04	3.0E-04
Liver	17	T	26	1.8E+03	1.0E+00	0.0E+00	0.0E+00
Other	23	T	25	0.0E+00	0.0E+00	5.4E-01	5.5E-01

Transfer compartment rate: 1.39000

EXHIBIT A.13. (contd)

INTDF Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem Five (INTDF)

Executed on: 09/27/88 at 17:12:04 Page 2

No. of OTHER compartments (TCMULT): 3 0.958913

TC, RT:	1	0.270000	0.115517
TC, RT:	2	0.900000E-01	0.115517E-01
TC, RT:	3	0.900000E-01	0.866375E-03

No. of bone compartments (TCMULT): 0 0.724638E-01

No. of specified organs (TCMULT): 1 2.61E-02

No. of specified organ compartments: 3

Organ Name	Comp. Index	Organ Index	Sub Index	TCORG (frac)	RTORG (rate)
Liver	1	1	1	0.30E-01	0.12E+00
Liver	2	1	2	0.10E-01	0.12E-01
Liver	3	1	3	0.10E-01	0.87E-03

Input prepared by: ______________________ Date: ____________

Input checked by: ______________________ Date: ____________

EXHIBIT A.13. (contd)

INTDF Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 5 (INTDF)

Executed on: 09/27/88 at 17:12:04 Page 3

Number of Nuclear Transformation Over 50 Years
In Source Organs or Tissue per Unit Intake of Activity
(Transformations/Bq) of CO60

Inhalation Class Y
F1: 5.0E-02

Oral

	CO60
Lung	0.0E+00
Stomach	3.6E+03
S Int.	1.4E+04
UL Int.	4.4E+04
LL Int.	8.2E+04
Bone	2.3E+02
Other	3.6E+05
Liver	4.0E+04

Inhalation

	CO60
Lung	9.7E+06
Stomach	1.9E+03
S Int.	7.3E+03
UL Int.	2.4E+04
LL Int.	4.4E+04
Bone	2.5E+02
Other	4.1E+05
Liver	4.5E+04

Committed Dose Equivalent Over 50 Years
In Target Organs or Tissue per Unit Intake of Activity
(Sv/Bq) of CO60

	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Sur	R Marrow
Oral	8.7E-10	1.5E-09	3.5E-09	5.6E-09	1.1E-08	8.4E-10	1.3E-09
Inhalation	3.3E-07	2.6E-08	6.7E-09	9.0E-09	7.6E-09	1.3E-08	1.6E-08

	Testes	Ovaries	Muscle	Thyroid	Liver
Oral	1.2E-09	3.1E-09	1.1E-09	8.3E-10	2.4E-09
Inhalation	1.7E-09	4.6E-09	1.7E-08	1.5E-08	3.2E-08

EXHIBIT A.13. (contd)

	Oral	Inhalation
Number of steps taken by the LSODES solver:	347	339
Number of F (DIFEQ2) evaluations:	453	469
Number of Jacobian evaluations:	7	7
Length of RWORK actually required:	964	998
Length of IWORK actually required:	30	30
Number of non-zero elements in Jacobian matrix:	82	93

A.6 EXTDF SAMPLE PROBLEM

The EXTDF code is used to prepare data files of external dose rate factors for use by the other codes of the GENII package. The input is quite short. No radionuclides need to be specified because the code reads the radionuclide master data file RMDLIB and calculates factors for every nuclide in the list. The input to this sample problem is shown in Exhibit A.14. The geometry demonstrated in Exhibit A.14 is an infinite slab source one meter thick with a 15-cm overburden. The dose point of interest is one meter above the surface of the covering overburden.

Output from the example calculation is given in Exhibit 15. The output defines the nature and composition of the various shield layers, provides information on the selected shield thicknesses and geometry, and provides limited information on the build-up factors used in the calculations. The column of radionuclides and associated dose rate factors is purposely formatted in this fashion to ease editing incorporation into the GENII system data files. This structure is compatible with the GENII file GRDF.DAT. The units displayed are selected using the IEXTU parameter illustrated in Exhibit A.14. Selection of this parameter must be appropriate to the geometry chosen. The user is referred to the input instructions.

A.7 DITTY SAMPLE PROBLEM

The DITTY sample problem represents the most common use of DITTY; the calculation of long-term population dose to a downstream population from a time-varying release to surface water. The input file for Sample Problem 7 is presented as Exhibit A.16. The waterborne release is given in terms of curies/year released into the river. The input of the source to the river is selected in this example to be via an input file copied into the input buffer WATREL.DAT. This file is presented as Exhibit A.17. The sample input file of Exhibit A.17 contains data for three radionuclides as a series of time/release quantity pairs. Because the parameter TZR is not set in the DITTY input file, the times in the WATREL file are assumed to be years since the start of the release in the year 2000 A.D.

EXHIBIT A.14. GENII Input File - Sample Problem 6

```
GENII Sample Problem 6 (EXTDF)
 &INPUT
  JBUF = 1,
  IGEOM=5,
  IEXTU = 3,
  ANG1 = 90.0, NSHLD=3,
  X = 215.,
  T =       100.0,  15.0,  100.0,
 &END
0   16       1.8    0.0     0.0   0.0    0.0
0   16       0.0    1.8     0.0   0.0    0.0
1    3       0.0    0.0 .00129   0.0    0.0
```

EXHIBIT A.15. GENII Output File - Problem 6

EXTDF Dose Calculation Program
(Version 1.351 30-Aug-88)

Case title: GENII Sample Problem 6 (EXTDF)

Executed on: 09/27/88 at 17:20:15 Page 1

Shield composition (gm/cc):

	1	2	3	4	5
ORDCONC	1.8E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
ORDCONC	0.0E+00	1.8E+00	0.0E+00	0.0E+00	0.0E+00
AIR	0.0E+00	0.0E+00	1.3E-03	0.0E+00	0.0E+00

Shield thickness (cm):
1.0E+02 1.5E+01 1.0E+02

Geometry index:	5
INFINITE SLAB source	
SLAB shield	
Distance to detector:	2.150E+02 cm
Angle:	0.0 degrees
Source thickness:	100.00 cm
Taylor build-up data for shield:	1
with effective atomic number:	10.0

Input prepared by: ______________________ Date: __________

Input checked by: ______________________ Date: __________

Units are person-Sv/yr per Bq/m3 (GENII)

H 3	0.00E+00
BE10	1.66E-15
C 14	8.89E-19
N 13	9.53E-11
F 18	9.23E-11
NA22	2.77E-10
NA24	1.07E-09
SI31	2.32E-13
P 32	1.56E-13

EXHIBIT A.15. (contd)

P 33	2.12E-17
S 35	1.31E-18
CL36	5.16E-15
K 40	2.87E-11
AR39	1.71E-15
AR41	1.90E-10
CA41	0.00E+00
CA45	2.40E-17
SC46	2.83E-10
CR51	2.43E-12
MN54	9.20E-11
MN56	3.27E-10
FE55	0.00E+00
FE59	1.73E-10
CO57	7.80E-13
CO58	1.08E-10
CO60	3.83E-10
NI59	0.00E+00
NI63	6.96E-24
NI65	9.62E-11
CU64	1.80E-11
ZN65	9.85E-11
ZN69M	4.53E-11
ZN69	1.45E-14
GA72	5.28E-10
AS76	5.68E-11
SE75	1.17E-11
SE79	5.17E-19
BR82	3.36E-10
BR83	6.85E-13
KR83M	8.11E-26
BR84	4.29E-10
KR85M	4.00E-12
KR85	2.11E-13
KR87	1.72E-10
RB87	3.08E-17
KR88	4.44E-10
RB88	1.57E-10
KR89	3.89E-10
RB89	4.04E-10
SR89	1.14E-13
SR87M	2.03E-11
RB86	1.41E-11
SR85	4.74E-11
SR90	1.28E-15
Y 90	3.83E-13
SR91	8.95E-11
Y 91M	5.96E-11
Y 91	6.76E-13
SR92	2.55E-10

EXHIBIT A.15. (contd)

Y 92	4.41E-11
Y 93	1.62E-11
MO93	0.00E+00
ZR93	1.35E-24
NB93M	0.00E+00
ZR95	7.83E-11
NB95M	1.59E-12
NB95	9.19E-11
ZR97	2.64E-11
NB97M	6.14E-11
NB97	6.44E-11
NB94	1.55E-10
MO99	1.29E-11
TC99M	6.18E-13
TC99	4.52E-17
TC101	2.77E-11
RU103	4.67E-11
PD103	7.62E-15
RH103M	1.13E-25
RU105	7.20E-11
RH105	6.03E-12
RU106	2.36E-11
PD107	0.00E+00
PD109	8.98E-14
AG110M	3.54E-10
AG111	1.78E-12
CD109	0.00E+00
CD113M	1.76E-15
CD115M	3.61E-12
CD115	1.82E-11
IN115M	1.16E-11
IN111	6.56E-12
IN114M	9.35E-12
SN113	1.23E-13
IN113M	1.60E-11
SN117M	6.14E-13
SN119M	6.42E-19
SN121M	0.00E+00
SN121	0.00E+00
SN123	1.08E-12
I 125	5.10E-23
SN125	5.06E-11
SB125	4.23E-11
TE125M	1.96E-15
SN126	3.53E-14
SB126M	1.56E-10
SB126	2.71E-10
SB122	4.97E-11
SB124	3.09E-10
SB127	6.43E-11

EXHIBIT A.15. (contd)

TE127M	7.22E-15
TE127	5.10E-13
TE123M	5.83E-13
TE129M	2.84E-12
TE129	5.62E-12
I 129	5.72E-19
TE131M	1.87E-10
TE131	4.14E-11
I 131	2.65E-11
XE131M	1.36E-14
TE132	5.58E-12
I 132	2.82E-10
TE133M	3.38E-10
TE133	1.24E-10
I 133	5.93E-11
XE133M	6.50E-13
XE133	2.84E-14
TE134	7.85E-11
I 134	3.41E-10
CS134M	8.95E-14
CS134	1.77E-10
I 130	2.07E-10
I 135	2.70E-10
XE135M	3.87E-11
XE135	7.86E-12
CS135	4.52E-18
XE137	2.64E-11
CS137	5.33E-11
XE138	2.30E-10
CS138	4.65E-10
CS139	6.25E-11
BA139	1.43E-12
BA140	1.59E-11
LA140	3.64E-10
CS136	2.70E-10
BA141	9.76E-11
LA141	8.96E-12
CE141	3.36E-13
BA142	1.20E-10
LA142	6.63E-10
CE143	1.36E-11
PR143	1.45E-14
CE144	7.61E-14
PR144M	1.70E-19
PR144	6.99E-12
PR142	1.02E-11
ND147	8.51E-12
PM147	2.83E-17
SM147	0.00E+00
PM148M	2.24E-10

EXHIBIT A.15. (contd)

PM148	9.44E-11
PM149	5.01E-13
PM151	2.31E-11
SM151	1.25E-22
SM153	3.35E-13
EU152M	4.07E-11
EU152	1.63E-10
EU154	1.63E-10
EU155	1.67E-13
EU156	2.55E-10
GD153	2.10E-13
GD159	2.19E-12
TB160	1.41E-10
TB161	2.85E-15
DY165	1.56E-12
HO166M	1.45E-10
HO166	3.73E-12
ER169	1.15E-16
ER171	2.08E-11
TA182	1.90E-10
W 181	1.51E-15
W 185	4.86E-16
W 187	4.30E-11
RE187	0.00E+00
OS185	6.43E-11
OS191	1.83E-13
IR192	6.68E-11
HG203	4.89E-12
TH230	4.90E-16
RA226	2.50E-14
RN222	2.83E-10
PB210	1.31E-20
BI210	3.15E-14
PO210	9.75E-16
U 232	5.06E-16
TH232	2.92E-16
RA228	9.00E-31
AC228	1.40E-10
TH228	1.77E-14
RA224	3.05E-13
PB212	3.68E-12
BI212	3.39E-10
U 234	2.78E-16
U 236	3.56E-18
U 235	8.96E-13
TH231	1.82E-14
PA231	1.68E-12
AC227	6.81E-16
TH227	3.42E-12
FR223	1.40E-12

EXHIBIT A.16. (contd)

RA223	1.66E-11
U 237	2.09E-12
NP237	5.14E-14
PA233	1.37E-11
U 233	1.26E-15
TH229	4.33E-13
RA225	8.50E-17
AC225	2.27E-11
U 238	3.11E-18
TH234	2.05E-12
PA234	2.46E-10
PU236	2.64E-18
PU237	2.33E-13
AM242M	1.14E-15
AM242	6.85E-14
CM242	7.11E-20
PU242	8.15E-20
NP238	8.65E-11
PU238	8.71E-20
CM244	5.23E-20
PU244	9.13E-23
U 240	4.10E-11
PU240	9.66E-20
CM245	3.35E-13
PU241	0.00E+00
AM241	7.18E-17
CM246	8.91E-23
CM247	3.52E-11
CM243	2.07E-12
PU243	1.92E-13
AM243	1.82E-14
NP239	3.17E-12
PU239	3.30E-16
CM248	4.83E-20
CF252	8.61E-19

EXHIBIT A.16. GENII Input File - Sample Problem 7

```
GENII Sample Problem 7:  DITTY Long-Term Surface Water Release
    3
H 3
C 14
CL36
 &INPUT IWAT=1, IPATH=2, LUW=2, IPOPL=2,
  CFLO=120000.,
  RM=1.0,
  PL1(1)=294830.,391538.,431210.,469891.,1273208.,4932964.,
  TL(1)=1990., 2100.,2200.,2300.,2990.,11900.,
  NTL=6,
  USAGE(1)=0.3,0.,0.,0.,438.,17.,17.,
  CONSUM(1)=15.,276.,20.,230.,40.,30.,8.5,
  EXTIM=2920.,MOPYR=6, RIRR=150.,
  GRWP(1)=90.,90.,90.,30.,3*90.,
  YELD(1)=1.5,4.,0.84,1.3,3*0.84,
 &END
```

EXHIBIT A.17. GENII Input File WATREL.DAT - Sample Problem 7

```
DITTY Sample Surface Water Release Input
3
C 14        50
6.1872E+027.2649E-03
6.6604E+024.7932E-02
7.1708E+021.5038E-01
7.7210E+022.5798E-01
8.3143E+023.1270E-01
8.9541E+023.3794E-01
9.6439E+023.4616E-01
1.0388E+033.4491E-01
1.1190E+033.4169E-01
1.2054E+033.3814E-01
1.2987E+033.3434E-01
1.3992E+033.3030E-01
1.5077E+033.2600E-01
1.6245E+033.2142E-01
1.7506E+033.1656E-01
1.8865E+033.1140E-01
2.0331E+033.0592E-01
2.1911E+033.0013E-01
2.3615E+032.9401E-01
2.5452E+032.8755E-01
2.7433E+032.8074E-01
2.9569E+032.7358E-01
3.1872E+032.6606E-01
3.4355E+032.5819E-01
3.7033E+032.4996E-01
3.9921E+032.4138E-01
4.3034E+032.3246E-01
4.6391E+032.2320E-01
5.0011E+032.1364E-01
5.3914E+032.0379E-01
5.8122E+031.9367E-01
6.2660E+031.8333E-01
6.7553E+031.7279E-01
7.2829E+031.6211E-01
7.8518E+031.5133E-01
8.4652E+031.4051E-01
9.1266E+031.2970E-01
9.8398E+031.1898E-01
1.0609E+041.0841E-01
1.1438E+049.8066E-02
1.2332E+048.8013E-02
1.3296E+047.8325E-02
1.4336E+046.9070E-02
1.5456E+046.0312E-02
1.6665E+045.2109E-02
1.7968E+044.4509E-02
1.9373E+043.7552E-02
```

EXHIBIT A.17. (contd)

2.0888E+043.1263E-02
2.2522E+042.5657E-02
2.4284E+043.5549E-14
H 3 26
6.1872E+024.7039E-17
6.4163E+024.0034E-17
6.6541E+022.6880E-17
6.9010E+021.4335E-17
7.1572E+026.1280E-18
7.4231E+022.1265E-18
7.6991E+026.0920E-19
7.9855E+021.4723E-19
8.2828E+023.0781E-20
8.5913E+025.7119E-21
8.9116E+029.6142E-22
9.2440E+021.4889E-22
9.5889E+022.1358E-23
9.9470E+022.8412E-24
1.0319E+033.4999E-25
1.0704E+033.9820E-26
1.1105E+034.1724E-27
1.1520E+034.0137E-28
1.1951E+033.5332E-29
1.2399E+032.8366E-30
1.2863E+032.0698E-31
1.3346E+031.3676E-32
1.3846E+038.1527E-34
1.4365E+034.3675E-35
1.4904E+032.0941E-36
1.5464E+038.9489E-38
CL36 51
6.1872E+022.0473E-04
6.4163E+026.3379E-04
6.6541E+021.6255E-03
6.9010E+023.4837E-03
7.1572E+026.3087E-03
7.4231E+029.7953E-03
7.6991E+021.3290E-02
7.9855E+021.6134E-02
8.2828E+021.8013E-02
8.5913E+021.9020E-02
8.9116E+021.9457E-02
9.2440E+021.9610E-02
9.5889E+021.9652E-02
9.9470E+021.9661E-02
1.0319E+031.9661E-02
1.0704E+031.9659E-02
1.1105E+031.9658E-02
1.1520E+031.9656E-02
1.1951E+031.9654E-02

1.2399E+031.9652E-02
1.2863E+031.9650E-02
1.3346E+031.9647E-02
1.3846E+031.9645E-02
1.4365E+031.9643E-02
1.4904E+031.9640E-02
1.5464E+031.9638E-02
1.6044E+031.9635E-02
1.6647E+031.9632E-02
1.7273E+031.9630E-02
1.7922E+031.9627E-02
1.8596E+031.9624E-02
1.9295E+031.9620E-02
2.0021E+031.9617E-02
2.0774E+031.9614E-02
2.1556E+031.9610E-02
2.2368E+031.9606E-02
2.3210E+031.9603E-02
2.4084E+031.9599E-02
2.4991E+031.9595E-02
2.5933E+031.9590E-02
2.6910E+031.9586E-02
2.7925E+031.9581E-02
2.8978E+031.9577E-02
3.0070E+031.9572E-02
3.1204E+031.9566E-02
3.2382E+031.9561E-02
3.3603E+031.9334E-02
3.4871E+039.1797E-03
3.6187E+033.2974E-04
3.7553E+037.5749E-07
3.8971E+031.8652E-10

EXHIBIT A.18. GENII Output File - Sample Problem 7

DITTY Dose Calculation Program
(GENII Version 1.339 22-Aug-88)

Integrated population dose calculated for chronic liquid release
Release from time 2000. A.D. onward for 10,000 years
Case title: GENII Sample Problem 7: DITTY Long-Term Surface Water Release
Executed on: 08/25/88 at 14:43:15.0 Page 1

---- DATA LIBRARIES USED --(File)-----

Master Radionuclide Data:	(2)
RMDLIB - Radionuclide Master Library (4-Dec-87 RAP)	
Food Concentration Ratios:	(8)
Food Transfer Factor Library - PNL xxxx (BAN 19-Aug-88) (UPDATED LEACHING FA	
Fresh Water Bioaccumulation Factors:	(9)
Bioaccumulation Factor Library - PNL xxxx (5-Aug-88)	
External Exposure D.F.'s:	(10)
External Dose Factors for GENII in person-Sv/yr per Bq/n (23-Mar-88 RAP)	
Inhalation/Ingestion D.F.'s:	(30)
DITTY Internal Dose Factors - 19-Aug-88 (RAP)	
Waterborne Release Data:	(31)
DITTY Sample Surface Water Release Input	

---- MASTER RADIONUCLIDE CONTROL LIST --------------------------------------

H 3 C 14 CL36

---- TERRESTRIAL/AQUATIC PATHWAY DATA FOR AN AVERAGE INDIVIDUAL ------------

Pathway	Growing Period (days)	Yield (kg/m2)	Consumption (kg/yr)	Pathway	Usage (kg or hr/yr)
LEAFY VEG	9.0E+01	1.5E+00	1.5E+01	FISH	3.0E-01
OTHER VEG	9.0E+01	4.0E+00	2.8E+02	CRUSTACEA	0.0E+00
EGGS	9.0E+01	8.4E-01	2.0E+01	MOLLUSKS	0.0E+00
MILK	3.0E+01	1.3E+00	2.3E+02	PLANTS	0.0E+00
BEEF	9.0E+01	8.4E-01	4.0E+01	DRINKING WATER	4.4E+02
PORK	9.0E+01	8.4E-01	3.0E+01	SEDIMENT EXPOSU	1.7E+01
POULTRY	9.0E+01	8.4E-01	8.5E+00	SWIMMING TIME	1.7E+01

External Exposure Time: 2.92E+03 hr/yr

---- LIQUID RELEASE PARAMETERS --

River Flow Rate, (ft3/sec) :	1.2E+05	Months/Year Irrigated :	6.0E+00
Reconcentration Ratio :	1.0E+00	Irrigation Rate	
Mixing Ratio :	1.0E+00	(liters/m2/month) :	1.5E+02

Input Prepared By: ______________________________ Date: _______________

Input Checked By: ______________________________ Date: _______________

DITTY Dose Calculation Program
(GENII Version 1.339 22-Aug-88)

Integrated population dose calculated for chronic liquid release
Release from time 2000. A.D. onward for 10,000 years
Case title: GENII Sample Problem 7: DITTY Long-Term Surface Water Release
Executed on: 08/25/88 at 14:43:15.0 Page 2

---- WATER RELEASE OF EACH RADIONCLIDE PER 70-YR PERIOD (Ci) ----

Radio-nuclide	Period/	Activity	Period/	Activity	Period/	Activity	Period/	Activity	Period/	Activity
H 3	9	5.1E-16	10	1.9E-15	11	2.8E-16	12	1.4E-17	13	3.8E-19
	14	7.9E-21	15	1.6E-22	16	3.4E-24	17	6.8E-26	18	1.2E-27
	19	2.1E-29								
C 14	9	1.4E-01	10	4.0E+00	11	1.3E+01	12	2.0E+01	13	2.3E+01
	14	2.4E+01	15	2.4E+01	16	2.4E+01	17	2.4E+01	18	2.4E+01
	19	2.3E+01	20	2.3E+01	21	2.3E+01	22	2.3E+01	23	2.3E+01
	24	2.2E+01	25	2.2E+01	26	2.2E+01	27	2.2E+01	28	2.2E+01
	29	2.2E+01	30	2.1E+01	31	2.1E+01	32	2.1E+01	33	2.1E+01
	34	2.1E+01	35	2.0E+01	36	2.0E+01	37	2.0E+01	38	2.0E+01
	39	2.0E+01	40	2.0E+01	41	1.9E+01	42	1.9E+01	43	1.9E+01
	44	1.9E+01	45	1.9E+01	46	1.9E+01	47	1.8E+01	48	1.8E+01
	49	1.8E+01	50	1.8E+01	51	1.8E+01	52	1.8E+01	53	1.8E+01
	54	1.7E+01	55	1.7E+01	56	1.7E+01	57	1.7E+01	58	1.7E+01
	59	1.7E+01	60	1.7E+01	61	1.6E+01	62	1.6E+01	63	1.6E+01
	64	1.6E+01	65	1.6E+01	66	1.6E+01	67	1.6E+01	68	1.5E+01
	69	1.5E+01	70	1.5E+01	71	1.5E+01	72	1.5E+01	73	1.5E+01
	74	1.5E+01	75	1.5E+01	76	1.4E+01	77	1.4E+01	78	1.4E+01
	79	1.4E+01	80	1.4E+01	81	1.4E+01	82	1.4E+01	83	1.4E+01
	84	1.4E+01	85	1.3E+01	86	1.3E+01	87	1.3E+01	88	1.3E+01
	89	1.3E+01	90	1.3E+01	91	1.3E+01	92	1.3E+01	93	1.3E+01
	94	1.2E+01	95	1.2E+01	96	1.2E+01	97	1.2E+01	98	1.2E+01
	99	1.2E+01	100	1.2E+01	101	1.2E+01	102	1.2E+01	103	1.2E+01
	104	1.1E+01	105	1.1E+01	106	1.1E+01	107	1.1E+01	108	1.1E+01
	109	1.1E+01	110	1.1E+01	111	1.1E+01	112	1.1E+01	113	1.1E+01
	114	1.0E+01	115	1.0E+01	116	1.0E+01	117	1.0E+01	118	1.0E+01
	119	1.0E+01	120	1.0E+01	121	9.9E+00	122	9.8E+00	123	9.7E+00
	124	9.6E+00	125	9.5E+00	126	9.5E+00	127	9.4E+00	128	9.3E+00
	129	9.2E+00	130	9.1E+00	131	9.1E+00	132	9.0E+00	133	8.9E+00
	134	8.8E+00	135	8.8E+00	136	8.7E+00	137	8.6E+00	138	8.6E+00

92124560138

	139	8.5E+00	140	8.4E+00	141	8.3E+00	142	8.3E+00	143	8.2E+00
CL36	9	3.5E-03	10	1.4E-01	11	6.2E-01	12	1.1E+00	13	1.3E+00
	14	1.4E+00	15	1.4E+00	16	1.4E+00	17	1.4E+00	18	1.4E+00
	19	1.4E+00	20	1.4E+00	21	1.4E+00	22	1.4E+00	23	1.4E+00
	24	1.4E+00	25	1.4E+00	26	1.4E+00	27	1.4E+00	28	1.4E+00
	29	1.4E+00	30	1.4E+00	31	1.4E+00	32	1.4E+00	33	1.4E+00
	34	1.4E+00	35	1.4E+00	36	1.4E+00	37	1.4E+00	38	1.4E+00
	39	1.4E+00	40	1.4E+00	41	1.4E+00	42	1.4E+00	43	1.4E+00
	44	1.4E+00	45	1.4E+00	46	1.4E+00	47	1.4E+00	48	1.4E+00
	49	1.2E+00	50	7.7E-01	51	4.2E-01	52	1.0E-01	53	1.4E-02
	54	2.5E-03	55	3.1E-05	56	5.9E-06				

DITTY Dose Calculation Program
(GENII Version 1.339 22-Aug-88)

Integrated population dose calculated for chronic liquid release
Release from time 2000. A.D. onward for 10,000 years
Case title: GENII Sample Problem 7: DITTY Long-Term Surface Water Release
Executed on: 08/25/88 at 14:43:15.0 Page 3

---- POPULATION DATA ----

Population for Chronic Waterborne Release at the following Times A.D.:

Time	Population
1990.	2.9E+05
2100.	3.9E+05
2200.	4.3E+05
2300.	4.7E+05
2990.	1.3E+06
11900.	4.9E+06

DITTY Dose Calculation Program
(GENII Version 1.339 22-Aug-88)

Integrated population dose calculated for chronic liquid release
Release from time 2000. A.D. onward for 10,000 years
Case title: GENII Sample Problem 7: DITTY Long-Term Surface Water Release
Executed on: 08/25/88 at 14:43:15.0 Page 4

Population for Waterborne Release:

Period/PL	Period/PL	Period/PL	Period/PL	Period/PL	Period/PL
0 0.0E+00	1 3.3E+05	2 3.9E+05	3 4.2E+05	4 4.5E+05	5 4.9E+05
6 5.7E+05	7 6.5E+05	8 7.3E+05	9 8.1E+05	10 8.9E+05	11 9.8E+05
12 1.1E+06	13 1.1E+06	14 1.2E+06	15 1.3E+06	16 1.3E+06	17 1.3E+06
18 1.4E+06	19 1.4E+06	20 1.4E+06	21 1.5E+06	22 1.5E+06	23 1.5E+06
24 1.5E+06	25 1.6E+06	26 1.6E+06	27 1.6E+06	28 1.7E+06	29 1.7E+06
30 1.7E+06	31 1.7E+06	32 1.8E+06	33 1.8E+06	34 1.8E+06	35 1.9E+06
36 1.9E+06	37 1.9E+06	38 1.9E+06	39 2.0E+06	40 2.0E+06	41 2.0E+06
42 2.1E+06	43 2.1E+06	44 2.1E+06	45 2.1E+06	46 2.2E+06	47 2.2E+06
48 2.2E+06	49 2.3E+06	50 2.3E+06	51 2.3E+06	52 2.3E+06	53 2.4E+06
54 2.4E+06	55 2.4E+06	56 2.5E+06	57 2.5E+06	58 2.5E+06	59 2.5E+06
60 2.6E+06	61 2.6E+06	62 2.6E+06	63 2.7E+06	64 2.7E+06	65 2.7E+06
66 2.7E+06	67 2.8E+06	68 2.8E+06	69 2.8E+06	70 2.9E+06	71 2.9E+06
72 2.9E+06	73 3.0E+06	74 3.0E+06	75 3.0E+06	76 3.0E+06	77 3.1E+06
78 3.1E+06	79 3.1E+06	80 3.2E+06	81 3.2E+06	82 3.2E+06	83 3.2E+06
84 3.3E+06	85 3.3E+06	86 3.3E+06	87 3.4E+06	88 3.4E+06	89 3.4E+06
90 3.4E+06	91 3.5E+06	92 3.5E+06	93 3.5E+06	94 3.6E+06	95 3.6E+06
96 3.6E+06	97 3.6E+06	98 3.7E+06	99 3.7E+06	100 3.7E+06	101 3.8E+06
102 3.8E+06	103 3.8E+06	104 3.8E+06	105 3.9E+06	106 3.9E+06	107 3.9E+06
108 4.0E+06	109 4.0E+06	110 4.0E+06	111 4.0E+06	112 4.1E+06	113 4.1E+06
114 4.1E+06	115 4.2E+06	116 4.2E+06	117 4.2E+06	118 4.2E+06	119 4.3E+06
120 4.3E+06	121 4.3E+06	122 4.4E+06	123 4.4E+06	124 4.4E+06	125 4.4E+06
126 4.5E+06	127 4.5E+06	128 4.5E+06	129 4.6E+06	130 4.6E+06	131 4.6E+06
132 4.6E+06	133 4.7E+06	134 4.7E+06	135 4.7E+06	136 4.8E+06	137 4.8E+06
138 4.8E+06	139 4.8E+06	140 4.9E+06	141 4.9E+06	142 4.9E+06	143 4.9E+06

DITTY Dose Calculation Program
(GENII Version 1.339 22-Aug-88)

Integrated population dose calculated for chronic liquid release
Release from time 2000. A.D. onward for 10,000 years
Case title: GENII Sample Problem 7: DITTY Long-Term Surface Water Release
Executed on: 08/25/88 at 14:43:15.0 Page 5

Lifetime Effective Cumulative Dose Equivalent as a Function of Time

Period	Year	Dose
until	until	
10	2630.	2.29E-02
11	2700.	7.89E-01
12	2770.	3.73E+00
13	2840.	8.89E+00
14	2910.	1.53E+01
15	2980.	2.24E+01
16	3050.	2.99E+01
17	3120.	3.76E+01
18	3190.	4.54E+01
19	3260.	5.32E+01
20	3330.	6.12E+01
21	3400.	6.94E+01
22	3470.	7.76E+01
< shortened for presentation >		
138	11590.	1.02E+03
139	11660.	1.03E+03
140	11730.	1.04E+03
141	11800.	1.05E+03
142	11870.	1.05E+03
143	11940.	1.06E+03
144	12010.	1.07E+03

Dose in units of person-rem;
that is the cumulative population dose received by the local population over 10,000 years with an assumed 70-yr individual lifetime.

EXHIBIT A.18. (contd)

DITTY Dose Calculation Program
(GENII Version 1.339 22-Aug-88)

Integrated population dose calculated for chronic liquid release
Release from time 2000. A.D. onward for 10,000 years
Case title: GENII Sample Problem 7: DITTY Long-Term Surface Water Release
Executed on: 08/25/88 at 14:43:15.0 Page 9

Cumulative Population Dose Equivalent by Radionuclide

Radio-nuclide	Effective Dose Equivalent	External Dose	Annual Effective Dose Equivalent	Percent Of Total Dose
H 3	1.3E-18	9.9E-29	1.3E-18	0
C 14	9.6E+02	4.7E-02	9.6E+02	90
CL 36	1.1E+02	3.2E-04	1.1E+02	9

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

EXHIBIT A.17. (contd)

DITTY Dose Calculation Program
(GENII Version 1.339 22-Aug-88)

Integrated population dose calculated for chronic liquid release
Release from time 2000. A.D. onward for 10,000 years
Case title: GENII Sample Problem 7: DITTY Long-Term Surface Water Release
Executed on: 08/25/88 at 14:43:15.0 Page 10

Maximum Dose Increment Received By Population
In Year 5430 (70-yr Time Period Number No: 49)

Organ	Cumulative Dose Equivalent	Weighting Factors	Weighted Cumulative Dose Equivalent
Gonads	1.2E+01	2.5E-01	2.9E+00
Breast	1.2E+01	1.5E-01	1.8E+00
R Marrow	1.2E+01	1.2E-01	1.4E+00
Lung	1.2E+01	1.2E-01	1.4E+00
Thyroid	1.2E+01	3.0E-02	3.5E-01
Bone Sur	6.0E+00	3.0E-02	1.8E-01
S Int.	1.2E+01	6.0E-02	7.5E-01
UL Int.	1.2E+01	6.0E-02	7.5E-01
LL Int.	1.2E+01	6.0E-02	7.5E-01
Stomach	8.1E+00	6.0E-02	4.9E-01
Cumulative Effective Dose Equivalent			1.1E+01
External Dose			3.6E-04
Lifetime Effective Cumulative Dose Equivalent			1.1E+01

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

EXHIBIT A.17. (contd)

DITTY Dose Calculation Program
(GENII Version 1.339 22-Aug-88)

Integrated population dose calculated for chronic liquid release
Release from time 2000. A.D. onward for 10,000 years
Case title: GENII Sample Problem 7: DITTY Long-Term Surface Water Release
Executed on: 08/25/88 at 14:43:15.0 Page 11

Maximum Dose Increment Received By Individual (rem)
In Year 5430 (70-yr Time Period Number No: 49)

Radio-nuclide	Effective Dose Equivalent	External Dose	Annual Effective Dose Equivalent	Percent Of Total Dose
H 3	0.0E+00	0.0E+00	0.0E+00	0
C 14	3.2E-06	1.6E-10	3.2E-06	67
CL 36	1.6E-06	4.7E-12	1.6E-06	32

DITTY Dose Calculation Program
(GENII Version 1.339 22-Aug-88)

Integrated population dose calculated for chronic liquid release
Release from time 2000. A.D. onward for 10,000 years
Case title: GENII Sample Problem 7: DITTY Long-Term Surface Water Release
Executed on: 08/25/88 at 14:43:15.0 Page 12

Population Internal Dose To Organ by Radionuclide
In Year 5430 (70-yr Time Period Number No: 49)

Radionuclide	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
H 3	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
C 14	7.9E+00	4.5E+00	8.5E+00	8.5E+00	8.5E+00	4.1E+00	7.9E+00	7.9E+00
CL 36	3.7E+00	3.6E+00	4.0E+00	4.0E+00	4.0E+00	1.9E+00	3.7E+00	3.7E+00
Total internal	1.2E+01	8.1E+00	1.2E+01	1.2E+01	1.2E+01	6.0E+00	1.2E+01	1.2E+01

Radionuclide	Ovaries	Muscle	Thyroid	Kidneys	Liver	Spleen	S Wall
H 3	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
C 14	7.9E+00	8.1E+00	7.9E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CL 36	3.7E+00	3.7E+00	3.9E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Total internal	1.2E+01	1.2E+01	1.2E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Population Air Submersion and External Incremental Dose by Radionuclide
In Year 5430 (70-yr Time Period Number No: 49)

Radionuclide	Air Submer-sion	Exter-nal
H 3	0.0E+00	0.0E+00
C 14	4.4E-10	3.5E-04
CL 36	5.9E-12	1.0E-05
Total external	4.5E-10	3.6E-04

Dose in units of person-rem;
that is the cumulative population dose received by the local population with an assumed 70-yr individual lifetime.

DITTY Dose Calculation Program
(GENII Version 1.339 22-Aug-88)

Integrated population dose calculated for chronic liquid release
Release from time 2000. A.D. onward for 10,000 years
Case title: GENII Sample Problem 7: DITTY Long-Term Surface Water Release
Executed on: 08/25/88 at 14:43:15.0 Page 13

Population Internal Dose To Organ by Exposure Pathway

In Year 5430 (70-yr Time Period Number No: 49)

Pathway	Lung	Stomach	S Int.	UL Int.	LL Int.	Bone Su	R Marro	Testes
Inhalation	1.5E-04	8.7E-05	1.6E-04	1.6E-04	1.6E-04	7.9E-05	1.5E-04	1.5E-04
Ingestion (Terr)	6.4E+00	5.1E+00	6.8E+00	6.8E+00	6.8E+00	3.3E+00	6.3E+00	6.4E+00
Ingestion (Aqua)	4.8E+00	2.8E+00	5.2E+00	5.2E+00	5.2E+00	2.5E+00	4.8E+00	4.8E+00
Drinking Water	3.9E-01	2.4E-01	4.2E-01	4.2E-01	4.2E-01	2.0E-01	3.9E-01	3.9E-01
Total internal	1.2E+01	8.1E+00	1.2E+01	1.2E+01	1.2E+01	6.0E+00	1.2E+01	1.2E+01

Pathway	Ovaries	Muscle	Thyroid	Kidneys	Liver	Spleen	S Wall
Inhalation	1.5E-04	1.5E-04	1.5E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ingestion (Terr)	6.4E+00	6.4E+00	6.5E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ingestion (Aqua)	4.8E+00	5.0E+00	4.8E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Drinking Water	3.9E-01	4.0E-01	3.9E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Total internal	1.2E+01	1.2E+01	1.2E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Dose in units of person-rem;
that is the cumulative population dose received by the local population
with an assumed 70-yr individual lifetime.

As can be seen in Exhibit A.16, the river flow averages 120,000 cfs, and the release is assumed to be uniformly mixed in the river by the time it reaches the majority of the users of the water. The exposed population grows from 295,000 people in the year 1990 to about 4.9 million in ten thousand years. The population is assumed to drink the river water and to eat a small amount of fish from the river. Crops are irrigated with the river water for 6 months/year at a rate of 150 liters/m^2/month. The consumption parameters used mirror those defaults for an average individual provided in APPRENTICE.

The output for this sample problem is presented as Exhibit A.18. The pages are numbered in the upper right-hand corner. For this example, much of the interpretive graphic output has been turned off, to shorten the output. The first page is a quality assurance page, repeating and summarizing the input. The second page is a summary of the WATREL.DAT input file, with the releases integrated over the 70-year time increments used in DITTY. Page three repeats the population input data (this can be a larger output if the atmospheric dispersion options are turned on). The fourth page provides the population interpolated linearly into each of the 143 70-year time intervals. Pages 5 through 8 provide the cumulative lifetime population doses as a function of time for each time interval, in person-rem. The output has been shortened for presentation in this document. Page 9 presents the total cumulative population dose equivalent contributed by each radionuclide, in person-rem. The maximum incremental population dose, that is, the population dose received during the single 70-year time interval at which the population dose rate was the greatest, is given on page 10. The maximum dose increment received by an average individual in this population, during the period of maximum population dose accrual, by radionuclide, is given on page 11. The total population organ doses during the maximum dose rate period are given by radionuclide on page 12. Finally, the total population internal dose by organ by pathway during the maximum dose rate period is presented on page 13.

A.8 SAMPLE PROBLEM CALCULATION BATCH FILE

The sample problems are provided as a part of the GENII system distribution package, on a separate disk. Upon the establishment of the GENII system on a new computer, it is wise to run the sample problems and compare the calculated output with the samples provided in this document to ensure that the system is functioning correctly. This may be done in a single step using a batch file. The batch file used to prepare the sample problems in this appendix is provided on the sample problem disk. On the disk it is called simply SAMPLE.BAT. It is shown here as Exhibit A.19. This batch file was established for the GENII system resident on hard disk labeled C:, in a \GENII\ subdirectory, with the sample input on a floppy disk in drive A:. The batch file may be modified as needed for other situations.

A few comments may be made about this batch file. The "rem" notation is the DOS notation for a comment line. No commands are executed for the lines beginning with "rem". The "erase" command is standard APPRENTICE technique for assuring that correct data is used in all calculations. It clears the input file buffers of previously used information. Thus, if the user forgets to assign a file, the run will terminate rather than continue with the wrong input file. If no files are active with those names, a "FILE NOT FOUND" message will be displayed on the control monitor. This is an informative message, and should not be interpreted to mean that something is wrong. The "if errorlevel" commands are statements that prevent the code from performing unnecessary calculations should any one module of the system fail for any reason. Should you run the batch file and get results for the samples at the beginning and the end of the file, but not for one in the middle, it is because a single module has failed for some reason, and the batch file has circumvented the error and continued with the next set.

EXHIBIT A.19. GENII Execution Control File - All Sample Problems

```
CLS
rem                  GENII Sample Problem Execution Control File
rem                  5-Aug-88 RAP
rem
rem
rem                  GENII
rem                  Hanford Environmental Dosimetry Software System
rem
rem                  Pacific Northwest Laboratory
rem                  Richland WA
rem
rem                  Contact:  Bruce Napier (509) 375-3896
rem
 echo off
 erase  c:\genii\genii.in
 erase  c:\genii\pop.in
 erase  c:\genii\jointfre.in
 erase  c:\genii\chiq.in
 erase  c:\genii\foodprod.in
 erase  c:\genii\env.in
 erase  c:\genii\genii.out
 erase  c:\genii\env.out
 erase  c:\genii\genii2.out
 erase  c:\genii\dose.out
echo on
 copy a:jf20089.ave  c:\genii\jointfre.in
 copy a:pop200.87 c:\genii\pop.in
 copy a:sample1.in c:\genii\genii.in
 c:\genii\envin
 if errorlevel 1 goto stop1
 c:\genii\env
 if errorlevel 1 goto stop1
 c:\genii\dose
 if errorlevel 1 goto stop1
rem
 copy c:\genii\genii.out+ c:\genii\genii2.out+ c:\genii\dose.out a:sample1.out
rem
:stop1
rem
 echo off
 erase  c:\genii\genii.in
 erase  c:\genii\pop.in
 erase  c:\genii\jointfre.in
 erase  c:\genii\chiq.in
 erase  c:\genii\foodprod.in
 erase  c:\genii\env.in
 erase  c:\genii\genii.out
 erase  c:\genii\env.out
 erase  c:\genii\genii2.out
 erase  c:\genii\dose.out
```

EXHIBIT A.19. (contd)

```
echo on
 copy a:sample2.in c:\genii\genii.in
 c:\genii\envin
 if errorlevel 1 goto stop2
 c:\genii\env
 if errorlevel 1 goto stop2
 c:\genii\dose
 if errorlevel 1 goto stop2
rem
 copy c:\genii\genii.out+ c:\genii\genii2.out+ c:\genii\dose.out a:sample2.out
rem
:stop2
rem
 echo off
 erase  c:\genii\genii.in
 erase  c:\genii\pop.in
 erase  c:\genii\jointfre.in
 erase  c:\genii\chiq.in
 erase  c:\genii\foodprod.in
 erase  c:\genii\env.in
 erase  c:\genii\genii.out
 erase  c:\genii\env.out
 erase  c:\genii\genii2.out
 erase  c:\genii\dose.out
echo on
 copy a:sample3.in c:\genii\genii.in
 c:\genii\envin
 if errorlevel 1 goto stop3
 c:\genii\env
 if errorlevel 1 goto stop3
 c:\genii\dose
 if errorlevel 1 goto stop3
rem
 copy c:\genii\genii.out+ c:\genii\genii2.out+ c:\genii\dose.out a:sample3.out
rem
:stop3
rem
 echo off
 erase  c:\genii\genii.in
 erase  c:\genii\pop.in
 erase  c:\genii\jointfre.in
 erase  c:\genii\chiq.in
 erase  c:\genii\foodprod.in
 erase  c:\genii\env.in
 erase  c:\genii\genii.out
 erase  c:\genii\env.out
 erase  c:\genii\genii2.out
 erase  c:\genii\dose.out
echo on
 copy a:sample4.in c:\genii\genii.in
```

EXHIBIT A.19. (contd)

```
 c:\genii\envin
 if errorlevel 1 goto stop4
 c:\genii\env
 if errorlevel 1 goto stop4
 c:\genii\dose
 if errorlevel 1 goto stop4
rem
 copy c:\genii\genii.out+ c:\genii\genii2.out+ c:\genii\dose.out a:sample4.out
rem
:stop4
rem
copy a:sample5.in c:\genii\intdf.in
c:\genii\intdf
copy c:\genii\intdf.out a:sample5.out
rem
copy a:sample6.in c:\genii\extdf.in
c:\genii\extdf
copy c:\genii\extdf.out a:sample6.out
rem
copy a:sample7.in c:\genii\ditty.in
copy a:watrel.dat c:\genii\watrel.dat
c:\genii\ditty
copy c:\genii\ditty.out a:sample7.out
```

REFERENCES

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Sommer, D. J., R. G. Rau, and D. C. Robinson. 1981. *Population Estimates for the Areas Within a 50-Mile Radius of Four Reference Points on the Hanford Site*. PNL-4010, Pacific Northwest Laboratory, Richland, Washington.

APPENDIX B

SELF-GENERATED DIAGNOSTICS

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APPENDIX B

SELF-GENERATED DIAGNOSTICS

The GENII Software Package generates an alphabetical list of messages contained in Table B.1. The error type of each message is identified. There are five error types: 1) warnings, 2) scenarios errors, 3) program errors, 4) scenario/file errors, and 5) program/file errors. User response to these error types varies based on user interaction level.

Level 0 users of GENII may encounter warning messages. These should be considered informational; no action is necessary. Because Level 0 users interact with APPRENTICE, no scenario errors or scenario/file errors should be encountered. APPRENTICE should have ensured that all scenario errors and most scenario/file errors were avoided. However, in the continual process of upgrading APPRENTICE, errors may have been introduced. All scenario errors should be handled as program errors. Scenario/file errors indicate problems with the population, joint frequency, Chi/Q, or food production files. The authors should be notified of all program and file errors.

Level 1 users may encounter all five types of error messages. Warnings are informational only; no action is necessary. Scenario errors are frequently introduced when the user directly edits an input file. Scenario/file errors indicate a problem with the auxiliary input files. The authors should be notified of all program errors. If the user has not made any changes to the GENII data libraries, the authors should also be notified of any program/file errors.

B.1 SCENARIO ERRORS

Scenario errors reflect incompatibilities between option selections and input parameter values. Subroutine CHECK of program ENVIN attempts to identify scenario incompatibilities and stop execution of the program so that the user may make corrections before exposure and dose calculations are performed. When using the ENVIN/ENV/DOSE package, scenario errors are usually caused when edits are made to the input file. For example, an option flag is turned on, but changes are not made to the corresponding input parameters. Some options require complex input logic and consequently are more difficult than others to change at Level 1 usage. Notably, air transport options, near/far-field classification, and individual/population classification are more difficult to modify without error. If scenario errors are not corrected after the initial attempts, it is suggested that the user regenerate the scenario using APPRENTICE. It is probable that 1) the input file may have been corrupted or 2) the user needs APPRENTICES's guidance in constructing the particular scenario.

B.2 PROGRAM ERRORS

The authors have provided an error/upgrade form to assist the user in error notification and the authors in software configuration control. Use the form shown in Exhibit B.1 to notify the authors of program errors. It is most helpful if the input file (nnnnnnnn.IN), execution file (nnnnnnnn.BAT), and any auxiliary input files (e.g., population, joint frequency) are included on floppy disk.

B.3 SCENARIO/FILE ERRORS

If population, joint frequency, Chi/Q, or food production files have been prepared, the user should check the formats of any population, joint frequency, Chi/Q, and food production files used against the descriptions in Sections 2.2.2-2.2.5. Level 1 users should refer to Sections 2.2.1-2.2.12 for assistance in determining the cause of scenario/file errors.

B.4 PROGRAM/FILE ERRORS

Program/file errors usually indicate that the user, in attempting to expand the application of GENII for research purposes, has made incorrect changes to data files used by GENII. Check file format and usage as presented in Section 2.3 to determine the source of the error.

TABLE B.1. Self-Generated Diagnostics

Error Message		Error Type
	Cannot open file F77L.ERR, error # xxx	program
ACTIN:	Error - number of radionuclides: NNACT = xxxxxx	scenario
ACTIN:	Error - number of time periods. Radionuclide: xxxxxx, Times: yyyyyy	scenario
ACTIN:	Inventory for xxxxxx was outside 10,000-year time period.	warning
ACTIN:	NT for radionuclide xxxxxx is too large: yyyyyyy	scenario
ACTIN:	Radionuclide xxxxxx in release file not included in master list.	scenario
ACTIN:	Read error encountered. N: xxxxxx, T(N): yyyyyyy, C(N): zzzzzz	scenario/ file
ACUTE1:	XOQOPT invalid in AIRCAL: xxx	scenario
AIRLIN:	No internal dose factors for xxxxxx.	warning
BCHAIN:	Error in BCHAIN, positive argument xxxxxxxx.	program
CASE2:	NAMELIST read error encountered.	scenario
CHAIN:	Error in CHAIN, positive argument xxxxxxxx.	program
CHECK:	Air transport cannot be considered with basic concentrations.	scenario
CHECK:	Air transport option cannot be 2 or 3 for population.	scenario
CHECK:	Animal food storage times not input to acute scenario, defaults used.	warning
CHECK:	Average wind speed cannot be zero, sector xxx.	scenario
CHECK:	Basic concentration may not be input for path x when yyyyyyyy transport selected.	scenario
CHECK:	Cannot calculate population dose for near field scenario.	scenario
CHECK:	Cannot consider finite plume with input air concentration.	scenario

TABLE B.1. (contd)

Error Message	Error Type
CHECK: Cannot consider irrigation or air deposition during a non-agricultural scenario.	scenario
CHECK: Cannot drink or irrigate with salt water.	scenario
CHECK: Chi/Q value must be entered when air transport option = 1.	scenario
CHECK: Deep soil is considered. Waste depth cannot be zero.	scenario
CHECK: Derived concentration may not be input for path x when transport or basic concentrations are input.	scenario
CHECK: Drinking water exposure flag should be set.	scenario
CHECK: Drinking water is from water system; however, no derived conc. has been entered.	scenario
CHECK: Drinking water source flag incorrect.	scenario
CHECK: Finite and infinite cloud exposures cannot be considered in one scenario.	scenario
CHECK: Finite plume cannot be considered when chi/Q value entered.	scenario
CHECK: Invalid air transport option for individual.	scenario
CHECK: Invalid animal product no: xxx irrigation source index.	scenario
CHECK: Invalid atmospheric production definition for ingestion population.	scenario
CHECK: Invalid E/Q input option for acute release.	scenario
CHECK: Invalid population definition option: xxx	scenario
CHECK: Invalid residential irrigation source index.	scenario
CHECK: Invalid terrestrial food no: xxx irrigation source index.	scenario
CHECK: Loss of institutional control occurred before waste was stored. Invalid.	scenario

TABLE B.1. (contd)

Error Message	Error Type
CHECK: Maximum individual distance and direction must be entered when air transport option = 3. MI distance: xxxxxx MI direction index (where 1 is S -> N): yyyy	scenario
CHECK: Maximum number of distances that can be considered is 10. Input value for NDIST is xxx.	scenario
CHECK: Minimum distance cannot be less than yyy.	scenario
CHECK: No xxxxxxxx exposure paths have been selected: Please check input file.	scenario
CHECK: Not stack release, effluent temp. set to 0.0.	warning
CHECK: Not stack release, stack flow radius set to 0.0.	warning
CHECK: Not stack release, stack flow rate set to 0.0.	warning
CHECK: Not stack release, stack height set to 0.0.	warning
CHECK: Population grid must be used with air transport option = 0.	scenario
CHECK: Population grid must be used with air transport option = 2.	scenario
CHECK: Population-weighted chi/Q value must be entered when air transport option = 1.	scenario
CHECK: Production not specified for export.	scenario
CHECK: Stack radius cannot be zero.	scenario
CHECK: Surface water depth and flow rate cannot = 0.0	scenario
CHECK: Surface water flow rate cannot = 0.0.	scenario
CHECK: Surface water width, depth, or flow rate cannot = 0.0	scenario
CHECK: Waste degradation incompatible with far-field scenario.	scenario
CHECK: Waste thickness cannot be set to 0.0.	scenario
CHECK: When uniform production is assumed, consumption must be input.	scenario

TABLE B.1. (contd)

Error Message	Error Type
CHECK: When uniform production is assumed, total production must be input.	scenario
CHECK: xxxxxxxx exposure not selected: yyyyyyyy will not be considered. (warning only)	scenario
CHECK: xxxxxxxx transport has been selected: No inventory entered, please check input file.	scenario
CHECK: xxxxxxxx transport has not been selected: Inventory has been entered, please check input file.	scenario
CHECK: Yield cannot be 0.0 for animal product no. x.	scenario
CHECK: Yield cannot be 0.0 for food pathway x.	scenario
CHECK: Zero hours of inhalation exposure will equal zero dose.	scenario
CHECK: Zero inhalation rate will equal zero.	scenario
DUMRED Error while reading past unused data set. LUN: xxx Line yyy of zzz	program/ file
DUMRED: End of file reading past unused data set. LUN: xxx Line yyy of zzz	program/ file
EOVRQ: NUBAR is out if range.	scenario
EOVRQ: NMET is out of range.	scenario
EOVRQ: NDIST is out of range.	scenario
EXTDF: The following shield specs data rejected...	scenario
EXTDF: IGEOM xxx is out of range.	scenario
FILERR: Error code = 0 in FILERR	program
FILERR: Logical unit number = 0 in FILERR	program
FILERR: Error occurred while reading file \xxx\xxxxxxxx.xxx Assigned to LUN: yyy Message: zzzzzzzzzzzzzzzz	scenario/ file or program/ file

TABLE B.1. (contd)

Error Message	Error Type
FILERR: Error opening file named \xxx\xxxxxxxx.xxx Assigned to LUN: yyy Message: zzzzzzzzzzzzzzzz	scenario/ file or program/ file
FILERR: File out of order or other indexing problem \xxx\xxxxxxxx.xxx Assigned to LUN: yyy Message: zzzzzzzzzzzzzzzz	program/ file
FILERR: Premature end-of-file encountered in \xxx\xxxxxxxx.xxx Assigned to LUN: yyy Message: zzzzzzzzzzzzzzzz	scenario/ file or program/ file
IDNUC: There were xxxx unidentified radionuclides.	scenario
IDNUC: Unidentified radionuclide in input xxxxxx.	scenario
INTPOL: Error in direction in interpolation.	program
INTPOL: MI distance outside range of chi/Q file.	scenario
ISOSUB: SLTH = 0. Execution terminated in subroutine CYL	scenario
ISOSUB: SLTH = 0. Execution terminated in subroutine DISC	scenario
ISOSUB: VOLUME=0, execution terminated in subroutine ENDCYL	scenario
ISOSUB: X=0. Execution terminated in subroutine DSCSRC	scenario
LS2: Error return for LSODES2, ISTATE = xxx RWORK(11 to 14) aaa bbb ccc ddd IWORK(11 to 26) eee fff ggg hhh ...	program
METLIB: Alkaline Earth organs expected.	program
METLIB: No data for xxx; skipped.	warning
METLIB: Too many organs: xxx.	program/ file
NRGLIB: Energy library out of order. RMDLIB: xxxxxx ENERGY: yyyyyy	program/ file

TABLE B.1. (contd)

Error Message	Error Type
NUCTST: Too many radionuclides in this case (Max=100): xxxx	scenario
OPNFIL: Invalid value for IMODE: xxx	program
OPNFIL: Invalid value for LUN: xxx	program
ORDIN: INTDF can only handle 8-member chains.	program
REDFIL: File titles do not match, LUN 11 and 13. Assumed to be invalid case.	scenario
REDSET: Internal dose factors not found for xxxxxx.	warning
RLIBIN: Decay chain xxxx has improper order. Current member is yyyy After zzzzzz.	program/ file
RLIBIN: Improper number of radionuclides in library: xxxx.	program
SIJLIB: Target organ index is 0 (IT,IORG(it): xxx yyy.	program
SWCAL: DYXU = 0.0, invalid (divide by zero).	program
SWCAL: DZXU = 0.0, invalid (divide by zero).	program
SWCAL: The dilution calculation has failed. A value of 1E-20 will be returned for the mixing ratio.	warning
WBEDE: Invalid master organ index ...	program
WBEDE4: Invalid master organ index ...	program
XQCAL: MI location selection error: Direction index: xxx Distance: yyy	scenario
XQIN: Invalid INOPT in XQIN	program

EXHIBIT B.1. Software Change Packet

PNL SOFTWARE CHANGE PACKET — Change Packet Number [ ]

Software Package: GENII Hanford Environmental Dosimetry System

Program (indicate): APPRENTICE ENVIN ENV DOSE INTDF EXTDF DITTY

Document Title: Napier B. A., R. A. Peloquin, D. L. Strenge, and J. V. Ramsdell. 1988. Hanford Environmental Dosimetry Upgrade Project. The Hanford Environmental Radiation Dosimetry Software System. Vol I, II, and III. PNL-6584, Pacific Northwest Laboratory, Richland, WA.

CHANGE(S) AND/OR PROBLEM(S) REPORTED

(To be completed by person requesting change)

PROBLEM DOCUMENTATION INCLUDED

- ____ Input file that demonstrates problem
- ____ Error message
- ____ Output file annotated to demonstrate problem

Submitted by: ______________________________ Change Requester   ____________ Date

Approved by: ______________________________ PNL GENII Designated Expert   ____________ Date

Send to:
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